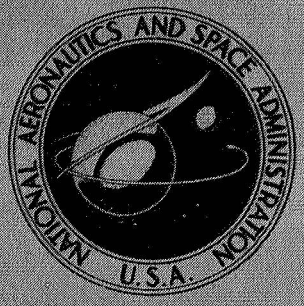
NASA CONTRACTOR REPORT



NASA CR-2453

NASA CR-2453

DEVELOPMENT OF AN ANALYSIS FOR THE DETERMINATION OF COUPLED HELICOPTER ROTOR/CONTROL SYSTEM DYNAMIC RESPONSE

Part II - Program Listing

Lawrence R. Sutton

Prepared by
ROCHESTER APPLIED SCIENCE ASSOCIATES, INC.
Rochester, N.Y.
for Langley Research Center

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION • WASHINGTON, D. C. • JANUARY 1975

1. Report No.	2. Government Accession No.	3. Recipient's Catalog No.
NASA CR 2453		

4. Title and Subtitle	5. Report Date
DEVELOPMENT OF AN ANALYSIS FOR THE DETERMINATION OF COUPLED HELICOPTER ROTOR/CONTROL SYSTEM DYNAMIC RESPONSE PART II, PROGRAM LISTING	JANUARY 1975
	6. Performing Organization Code
7. Author(s)	8. Performing Organization Report No.
LAWRENCE R. SUTTON	
	10. Work Unit No.
9. Performing Organization Name and Address	11. Contract or Grant No.
ROCHESTER APPLIED SCIENCE ASSOICATES, INC. ROCHESTER, NEW YORK	NAS1-10856
	13. Type of Report and Period Covered
12. Sponsoring Agency Name and Address	CONTRACTOR REPORT
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION WASHINGTON, DC 20546	14. Sponsoring Agency Code

15. Supplementary Notes

LAST OF TWO FINAL REPORTS.

16. Abstract

A THEORETICAL ANALYSIS IS DEVELOPED FOR A COUPLED HELICOPTER ROTOR SYSTEM TO ALLOW DETERMINATION OF THE LOADS AND DYNAMIC RESPONSE BEHAVIOR OF HELICOPTER ROTOR SYSTEMS IN BOTH STEADY-STATE FORWARD FLIGHT AND MANEUVERS. THE EFFECTS OF AN ANISOTROPICALLY SUPPORTED SWASHPLATE OR GYROSCOPE CONTROL SYSTEM AND A DEFORMED FREE WAKE ON THE ROTOR SYSTEM DYNAMIC RESPONSE BEHAVIOR ARE INCLUDED IN THE ANALYSIS.

17. Key Words (Suggested by Author(s))		18. Distribution Statement
HELICOPTER	ROTOR	
CONTROL SYSTEM	FREE WAKE	
DYNAMIC RESPONSE		STAR CATEGORY 02

19. Security Classif. (of this report)	20. Security Classif. (of this page)	21. No. of Pages	22. Price*
UNCLASSIFIED	UNCLASSIFIED	92	$4.75

*For sale by the National Technical Information Service, Springfield, Virginia 22151

CONTENTS

CONTENTS

DEVELOPMENT OF AN ANALYSIS FOR THE DETERMINATION OF COUPLED HELICOPTER ROTOR/CONTROL SYSTEM DYNAMIC RESPONSE

PART II - PROGRAM LISTING *

By Lawrence R. Sutton

Rochester Applied Science Associates, Inc.

SUMMARY

The computer program listing is presented for the program of investigating the effects of an anisotropically mounted flexible swashplate on a deformed free-wake on the dynamic steady-state forced response characteristics of helicopter rotor systems. For the free-wake effects to be included, this program is used in conjunction with the free-wake geometry program listed in NASA CR-2111. The listing in this volume corresponds to the calculations discussed in PART I.

INTRODUCTION

The determination of the effects of nonuniform control system (swashplate system or gyroscopic control system) along with the effects of nonuniform inflow due to free-wake on blade air loads and response for helicopters in steady maneuvers is essential in order to obtain more complete model of both aerodynamics and elastomechanics of the helicopter rotor system. The program listed here includes the effects of an anisotropically mounted flexible swashplate (or nonuniform gyroscopic control system) and a deformed free-wake on the dynamic steady-state forced response characteristics of helicopter rotor systems.

Three steps are necessary in obtaining blade response results including the effects of nonuniform inflow due to a free-wake and the effects of the nonuniformly supported control system.

1. Preliminary calculations (or measured data) are used to define rotor system performance parameters and flight conditions Definitions of model parameters and program contol variables are necessary for program operation.

---

*PART I - ANALYSIS AND APPLICATION is contained in NASA CR-2452.

2. The results of the free-wake analysis are necessary to account for the effect of a nonuniform downwash distribution acting on the rotor system. For this the program listed in NASA CR-2111 is used to obtain wake-induced velocity influence coefficients (stored on BDSIG file) and bound circulations (stored on BDGAM file) for transfer to and use by this blade-swashplate dynamic response program.

3. The blade response program listed in this report is then used to determine specified harmonics of blade flapwise, chordwise, and pitching moments; blade deflections and twist, and their slopes; and blade spear and axial forces. This program also provides the corresponding harmonics of the swashplate response. Since the blade system responds to a downwash field, an iterative procedure is necessary to obtain the final dynamic response.

Program input and output can be in English units or SI units.

```
      OVERLAY(NS6,0,0)
      PROGRAM NS6(INPUT,OUTPUT,PUNCH,ONE,TWO,THREE,EIGHT,NINE,TAPE1=ONE,
     1 TAPE2=TWO,TAPE3=THREE,TAPE4=PUNCH,TAPE5=INPUT,TAPE6=OUTPUT,
     2 TAPE8=EIGHT,TAPE9=NINE)
C     MAINLINE PROGRAM FOR FORCED RESPONSE
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX EPS(123),DETSV
      REAL ITH(10)
C
      COMMON/AERDM/DMS(4)
      COMMON/AERTP/AKT(4),ACT(4),AKP(4),ACP(4)
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/DIMS/NN1,NN2,NN3
      COMMON/RNAME/CS(4,20),SN(4,20)
      COMMON/RNAME1/CS1(4,6),SN1(4,6)
      COMMON/SCTAB/CPSY(24,20),SPSY(24,20)
      COMMON/EPSA/EPS,DETSV
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/NO1/MXCPK,MXKQ,MXSMB,MFASB,MXFAB
      COMMON/NO2/MXCSB,NBSBC,MXCPM,NBBC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NRIFC,NBISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NBBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO8/JYRO
      COMMON/GYR/GYM,GYK,GYC,GKB,GCB,GKP,GCP,GBP,GIX,GIY,GIZ
      COMMON/CYM/CY54,CY55
      COMMON/IPH1/NNFAZ,NNBS
      COMMON/ISMB/MS
      COMMON/IBRIG/MINPN,MAXPN
      COMMON/SWASH/SWGJ,SWEI,SWM,SWR
      COMMON/VEL1/VEL(10,24)
      COMMON/WA1/CONVG
      COMMON/WA2/GAM(240)
      COMMON/WA4/ALPH1(10,24),VELF(10,24),LTH
      COMMON/IWA1/IWAKE,NAERO,MABRO
      COMMON/WA5/ALLI
      COMMON/IWA3/MXIT
      COMMON/IWA2/ITI,NANR,IMAX,KTEST
      COMMON/IAR1/IAR(10)
      COMMON/IWA4/NN4,NN5,NN6
      COMMON/SI1/SI(10)
```

```
      COMMON/SUBS/Y1,Y2,Y3,Y4,Y5
      COMMON/IH/IH34
      COMMON/AERBP/BJ(4)
      COMMON/WA3/VZA1(13,33),VYA1(13,33),VZP1(13,33),VYP1(13,33)
      COMMON/NGAD/NHWI,NCVF,NPRS
      COMMON/VMAKE/VMAXI
      COMMON /IS1/ NFF
      COMMON/CYM1/CY56,CY57
      COMMON/NGAT/NWFC,NP6,NTRT
      COMMON/LINA/IINA,LAFI
      COMMON/CYM2/CY58
C
  100 ITI=0
      NCUT=6
      MODE=0
      DO 1 I1=1,10
    1 IAR(I1)=0
      READ(5,941)NN1,NN2,NN3,NN4,NN5,NN6,NWFC,NHWI,NCVF,NPRS
      READ(5,901)  Y1,Y2,Y3,Y4,Y5
      READ(5,941)  IWAKE,NAERO,MXIT,NAS,KTEST,IH34
      IF(IWAKE.EQ.0)  GO TO 2
      WRITE(6,905)
    2 READ(5,901)  ALLI
      READ(5,941)  (IAR(II),II=1,NAERO)
      NANR=NAS*NAERO
      IMAX=10
      DO 6 I2=1,10
    6 SI(I2)=0.0
      IF (IWAKE .NE.0) CALL OVERLAY(3LNS6,1,3,6HRECALL)
      CALL OVERLAY(3LNS6,1,1,6HRECALL)
      IF(MAERO.EQ.0)  GO TO 10
      NORNH=NFF-NF
      IF(MAXPN.LE.NORNH)  GO TO 10
      MAXPN=NORNH
      WRITE(6,906)MAXPN
   10 IF(NWHI.LE.MAXPN)  GO TO 11
      NHWI=MAXPN
      WRITE(6,907)NHWI
   11 CONTINUE
      IF (IWAKE.EQ.0)  GO TO 66
      IF(NP.EQ.0)  GO TO 12
      NP=0
      WRITE(6,908)NP
   12 CONTINUE
      IF(NCVF.GT.0)  GO TO 20
      NCVF=100
      WRITE(6,904)
   20 CONTINUE
      IF (ITI.EQ.0)  GO TO 66
   74 CONTINUE
```

```
      IF(MAKEO.EQ.0)GO TO 66
      DO 7 I2=1,10
    7 SI(I2)=0.0
      DO 3 MS=1,NB
    3 CALL ABROM
      REWIND 2
      REWIND 3
   66 MFP=0
      IF(NP.GT.MAXPN) GO TO 500
      IF(IWAKE.EQ.0) WRITE(6,940) NP
      CY1=CY2*NP*CY4
      IF(NB.GT.1) GO TO 65
      MS=1
      CALL OVERLAY(3LNS6,1,4,6HRECALL)
      CALL OVERLAY(3LNS6,1,5,6HRECALL)
      CALL OVERLAY(3LNS6,1,6,6HRECALL)
      CALL OVERLAY(3LNS6,2,0,6HRECALL)
      MFP=1
      IF(IWAKE.EQ.0) GO TO 4
      IF(NPRS.EQ.0) GO TO 13
      WRITE(6,940)NP
      GO TO 4
   13 IF(ITI.GE.MXIT) WRITE(6,940) NP
    4 CONTINUE
      REWIND 2
      REWIND 3
      CALL OVERLAY(3LNS6,1,4,6HRECALL)
      GO TO 69
   65 DO 67 MS=1,NB
      CALL OVERLAY(3LNS6,1,4,6HRECALL)
   67 CALL OVERLAY(3LNS6,1,5,6HRECALL)
      CALL OVERLAY(3LNS6,1,6,6HRECALL)
      CALL OVERLAY(3LNS6,2,0,6HRECALL)
      MFP=1
      IF (IWAKE.EQ.0) GO TO 5
      IF(NPRS.EQ.0) GO TO 14
      WRITE(6,940) NP
      GO TO 5
   14 IF(ITI.GE.MXIT) WRITE(6,940)NP
    5 CONTINUE
      REWIND 2
      REWIND 3
      DO 68 MS=1,NB
   68 CALL OVERLAY(3LNS6,1,4,6HRECALL)
   69 IF(IWAKE.EQ.0) GO TO 82
      IF(NP.LT.NHWI) GO TO 82
      IF(ITI.EQ.MXIT) GO TO 82
      CALL OVERLAY(3LNS6,1,2,6HRECALL)
      NP=0
      GO TO 81
```

```
   82 NP=NP+1
      REWIND 2
      REWIND 3
      GO TO 66
   81 CONTINUE
      REWIND 2
      REWIND 3
      IF (CONVG.G1.ALLI) GO TO 95
      ITI=MXIT
      GO TO 98
   95 ITI=ITI+1
   98 WRITE(6,993) ITI,ALLI,CONVG
      CALL OVERLAY(3LNS6,1,3,6HRECALL)
      GO TO 74
  500 READ(5,941) IGO
      IF (IGO.EQ.0) STOP
      GO TO 100
  901 FORMAT(8F10.0)
  905 FORMAT(/36X,*IF IWAKE EQUALS 1, SIGMA AND GAMMA ARRAYS MUST BE ATT
     1ACHED*)
  904 FORMAT(/36X,*SOLUTION WILL NOT CONVERGE WITH NCVF = 0, NCVF RESET
     1= 100*)
  906 FORMAT(/25X,*MAXPN HAS BEEN RESET TO THE MAXIMUM VALUE ALLOWED BY
     1THE VALUE OF NFF,MAXPN=*,I3)
  907 FORMAT(/41X,*NHWI CANNOT BE GREATER THAN MAXPN,NHWI RESET=*,I3)
  908 FORMAT(/40X,*FOR WAKE ITERATION NP MUST START AT 0,NP RESET=*,I3)
  941 FORMAT (16I5)
  940 FORMAT(1H1,56X,20HFORCED RESPONSE, NP=,I2,/59X,13HSTATE VECTORS/)
  993 FORMAT(/33X,5HITI =,I3,10X,6HALLI =,E15.7,5X,7HERROR =,E15.7)
      END
```

```
      SUBROUTINE AEROM
      REAL TC(34)
      REAL TMO(24)
      COMPLEX AMF(1230)
      COMPLEX AMA(1700)
      COMPLEX CY19A
      COMPLEX CY1,CY2,CY5,CY6
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      REAL LTH(10)
C        COMMON AREAS
C
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/NO1/MXCPK,MXKQ,MXSMB,MFASB,MXFAB
      COMMON/NO2/MXCSB,NMSBC,MXCPM,NEBC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NBIFC,NBISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/IBRIG/MINPN,MAXPN
      COMMON/WA4/ALPH1(10,24),VELF(10,24),LTH
      COMMON/VEL1/VEL(10,24)
      COMMON/IS1/NFF
      COMMON/DIMS/NN1,NN2,NN3
      COMMON/SCTAB/CPSY(24,20),SPSY(24,20)
      COMMON/SUB/Y(225)
      COMMON/SAIN/SD(7425)
      COMMON/AMFT/AMF
      COMMON /AMAT/AMA
      COMMON/IWA1/IWAKE,NAERO,MAERO
      COMMON/CYM/CY54,CY55
      COMMON/IWA4/NN4,NN5,NN6
      COMMON/ISMB/MS
      COMMON/IWA2/ITI,NANR,IMAX,KTEST
      COMMON/IL1/IL
      COMMON/CYM1/CY56,CY57
      COMMON/NGAT/NWFC,NP6,NTRT
      COMMON/CYM2/CY58
      IF(IWAKE.EQ.0) GO TO 4
      IF(MS.GT.1) GO TO 4
      DO 3 I5=1,NAERO
      DO 3 J5=1,NAS
    3 VEL(I5,J5)=CY4*CY50*VEL(I5,J5)
    4 CONTINUE
```

```
      DO 8 J5=1,NAS
    8 TMO(J5) =0.0
      MXNFF=2*NFF+1
      IL=0
      IF (NET .EQ. 0) GO TO 9
      READ(5,703) ((VEL(IRITE,JRITE),IRITE=1,NAERO),JRITE=1,NAS)
    9 IF(NN6 .EQ. 0) GO TO 810
      WRITE(6,801) ((VEL(I1,K1),I1=1,NAERO),K1=1,NAS)
  801 FORMAT(* INDUCED VELOCITIES FROM AERODM */(5G16.7))
  810 DO 10 I=1,34
   10 TC(I) = 0.
      IF(IWAKE.EQ.0) GO TO 2
      IF(MS.GT.1) GO TO 6
    2 DO 12 I=1,NN1
   12 AMA(I) = CMPLX(0.,0.)
    6 DO 5 I=1,NN2
    5 AMP(I)=CMPLX(0.,0.)
      IF(ITI.EQ.0) GO TO 7
      READ(2) SD
    7 DO 26 I=1,NS
      L=(I-1) * NSIZEY
      Y(203) = SD(L+203)
      IF(Y(203)-1) 26,13,26
   13 IL=IL+1
   14 DO 16 J=1,NSIZEY
   16 Y(J)=SD(L+J)
      LTH(IL)=Y(75)
      DO 24  K=1,NAS
      IF (IWAKE .EQ. 0) GO TO 17
      Y(180)=VEL(IL,K)
   17 CONTINUE
      IF (NET .EQ. 0) GO TO 18
      Y(180)=VEL(IL,K)
   18 CONTINUE
      CY19=(K-1)*(2.0*CY12)/NAS
      CY20 = SPSY(K,1)
      CY21 = CPSY(K,1)
      CY53=-CY47*(CY21*CY51+CY20*CY52)
      SCY53=SIN(CY53)
      CCY53=COS(CY53)
      SANG=Y(19)*CCY53+Y(20)*SCY53
      CANG=Y(20)*CCY53-Y(19)*SCY53
      PULL=CY54+CY55*CY56
      ROLL=CY48*CY16-CY55*CY57*CY17
      TURN=CY48*CY17+CY55*CY57*CY16+CY4
      CY22 = CY14 * CY16 * CY20
      CY23 = CY14 * CY16 * CY21
      CY24 = CY14 * CY17
      CY35=Y(28)*SANG-Y(11)*CANG
      CY36=Y(12)*CANG+Y(24)*SANG
```

```
      CY37=Y(11)*SANG+Y(28)*CANG
      CY38=Y(24)*CANG-Y(12)*SANG
      CCA=PULL*CY21+ROLL*CY20
      CCB=ROLL*CY21-PULL*CY20
      CY25=TURN*Y(16)*SANG+CCA*CY35+CCB*CY36
      CY26=TURN*Y(16)*CANG+CCA*CY37+CCB*CY38
      CY27=CY22
      CY28=CY23+TURN*CY58
      CY29 = Y(78) * CY25
      CY30 = Y(78) * CY26
      CY31=CY24+Y(180)-CCB*CY58
      CY32=CY31*Y(16)*SANG
      CY33=CY31*Y(16)*CANG
      CY34=CY31*Y(15)
      CY39=TURN*Y(15)-CCA*Y(29)-CCB*Y(25)
      SSS1=CY27*CY35+CY28*CY36+CY32+CY26*(Y(3)-CY58)
      SSS2=CY27*CY37+CY28*CY38+CY33-CY39*Y(4)-CY25*(Y(3)-CY58)
      SSS3=CY27*Y(29)+CY28*Y(25)-CY34-CY26*Y(4)
      SSS4=SSS3+CY30
      Y(82)=-CY39
      Y(83)=SSS1
      Y(84)=SSS2+Y(78)*CY39
      CALL AERO
      IF(NN6.EQ.0) GO TO 805
      WRITE(6,802) Y(83),Y(84),Y(90),Y(180),CY14
  802 FORMAT(* BLADE VELOCITIES FROM AEROM */(5G16.7))
      WRITE(6,803) Y(124),Y(125),Y(126)
  803 FORMAT(* BLADE STEADY LOADS PER UNIT LENGTH */(5G16.7))
  805 IF(IWAKE.EQ.0) GO TO 118
      ALPH1(IL,K)=Y(91)
      VELF(IL,K)=Y(90)
  117 FORMAT(10G12.4)
  118 CONTINUE
C     CREATE MATRIX C.
      TC(1)  = Y(123) * Y(78) - Y(117)
      TC(2)  = -Y(120)
      TC(3)  = Y(123)
      TC(4)  = -Y(121) * Y(78) + Y(115)
      TC(5)  = Y(118)
      TC(6)  = -Y(121)
      TC(7)   = Y(122) * Y(78) -Y(116)
      TC(8)   = -Y(119)
      TC(9)   = Y(122)
      TC(10) = Y(124)
      TC(11) = -Y(125)
      TC(12)=-Y(120)*CY26+Y(123)*CY25
      TC(13)=Y(123)*SSS1-Y(120)*SSS2
      TC(14) = Y(123) * CY39
      TC(15)=+Y(120)*SSS3+Y(123)*CY29-Y(117)*CY25
      TC(16) = Y(120) * CY39
```

```
      TC(17)=-Y(123)*SSS4+Y(117)*CY26
      TC(18)  = Y(126)
      TC(19)=+Y(118)*CY26-Y(121)*CY25
      TC(20)=Y(118)*SSS2-Y(121)*SSS1-Y(125)
      TC(21)  = -Y(121)  * CY39
      TC(22)=-Y(118)*SSS3-Y(121)*CY29+Y(115)*CY25
      TC(23)  = -Y(118)  * CY39
      TC(24)=+Y(121)*SSS4-Y(115)*CY26
      TC(25)   = -Y(126)
      TC(26)=-Y(119)*CY26+Y(122)*CY25
      TC(27)=Y(122)*SSS1-Y(119)*SSS2-Y(124)
      TC(28)   = Y(122)  * CY39
      TC(29)=+Y(119)*SSS3+Y(122)*CY29-Y(116)*CY25
      TC(30)   = Y(119)  * CY39
      TC(31)=-Y(122)*SSS4+Y(116)*CY26
      TC(32)= -Y(126)
      TC(33)= Y(124)
      TC(34)  = -Y(125)
      DO 22  NN=1,MXSMI
      N=NN-NFP1
      CALL PSYK(CPSY,SPSY,K,N,CY19A)
      IPQ=34*(IL-1)*MXSMI+(NN-1)*34
      IF(IWAKE .EQ. 0) GO TO 51
      IF(MS .GT. 1) GO TO 22
   51 DO 20 J=1,34
      AMA(IPQ+J)= AMA(IPQ+J)  - Y(75)  * TC(J)  * CY19A
   20 CONTINUE
   22 CONTINUE
      DO 220 NN=1,MXNFF
      N=NN-NFF-1
      CALL PSYK(CPSY,SPSY,K,N,CY19A)
      JPQ=3*(IL-1)*MXNFF+(NN-1)*3
      DO 220 J=1,3
  220 AMF(JPQ+J)=AMF(JPQ+J)-Y(75)*TC(J+31)*CY19A
      IF(NTRT.NE.1) GO TO 24
      TMO(K)=TMO(K)-Y(3)*Y(75)*(Y(124)*Y(35)+Y(125)*Y(36))
   24 CONTINUE
   26 CONTINUE
      IF(NTRT.NE.1) GO TO 808
      WRITE(6,807) (TMO(K),K=1,NAS)
  807 FORMAT(* BLADE THRUST MOMENT AT EACH AZIMUTH */(5G14.5))
  808 CONTINUE
      J=MXSMI*34*IL
      IF(IWAKE .EQ. 0) GO TO 52
      IF(MS .GT. 1) GO TO 53
   52 DO 28 I=1,J
   28 AMA(I)  = AMA(I) / NAS
   53 JF=MXNFF*3*IL
      DO 228 I=1,JF
  228 AMF(I)=AMF(I)/NAS
```

```
      IF(IWAKE .EQ. 0) GO TO 35
      WRITE(3) AMF
      GO TO 36
   35 WRITE(3) AMA,AMF
   36 CONTINUE
 9876 FORMAT (*0*,10G12.4)
  703 FORMAT(8F10.6)
  902 FORMAT(20X,2I5,3E15.7)
  903 FORMAT(10E13.6)
   30 RETURN
      END
```

```
      SUBROUTINE AERO
      COMPLEX CY1,CY2,CY5,CY6
      INTEGER CY43,CY45,CY3,CY18,CY44
      INTEGER CY40,CY41,CY42
      INTEGER CY18A
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /SUB/Y(225)
      COMMON/IH/IH34
      COMMON/II1/IL
      COMMON/SI1/SI(10)
      COMMON/SUBS/Y1,Y2,Y3,Y4,Y5
      EMT=CY4*CY50/CY9
      Y(90) = SQRT(Y(83) * Y(83) + Y(84) * Y(84))
      UN=Y(90)/(CY50*CY4)
      IF (Y(84)) 222,112,111
111   IF (Y(83)) 555,556,666
222   IF (Y(83)) 333,445,444
112   IF(Y(83)) 113,114,114
113   Y(91) = CY12
      GO TO 668
114   Y(91) =0.0
      GO TO 668
333   Y(91) = CY12-ATAN(ABS(Y(84)/Y(83)))
      GO TO 668
444   Y(91) = ATAN(ABS(Y(84)/Y(83)))
      GO TO 668
445   Y(91) = .5 *CY12
      GO TO 668
555   Y(91) = CY12 + ATAN(ABS(Y(84)/Y(83)))
      GO TO 668
556   Y(91)=1.5*CY12
      GO TO 668
666   Y(91) = 2. *CY12 - ATAN(ABS(Y(84)/Y(83)))
668   CONTINUE
      Y(92) = Y(90) / CY9
      Y(93) = 1. / (1. - Y(92) * Y(92))
      Y(94) = (2. - Y(92) * Y(92)) * Y(93)
      CALL NS1214 (EMT,UN,Y(91),Y(95),Y(96),Y(99),Y(97),Y(100),Y(98))
      IF(IH34.EQ.0) GO TO 760
      IF(CY19.LT.3.0) GO TO 760
      IF(CY19.GT.4.8) GO TO 760
      AS=(.22688+Y5)*(1.0-Y(92))
      IF(Y(91).LT.AS) GO TO 760
      IF(SI(IL).NE.0.0) GO TO 20
      SI(IL)=ASIN((Y(95)-Y3)/Y1)/Y2
```

```
 20 Y(95)=Y3+Y1*SIN(Y2*(CY19-SI(IL)))
    Y(99)=.5*(1.0-COS(Y2*(CY19-SI(IL))))*Y4
760 Y(101) = CY10 * Y(79) / 2.
    Y(102) = Y(101) * Y(90)
    Y(103) = Y(101) / Y(90)
    Y(104) = Y(101) * Y(79)
    Y(105) = Y(104) * CY12 / 2.
    Y(106) = Y(79) / 4. - Y(78)
    Y(107) = Y(84) * Y(95)
    Y(108) = Y(84) * Y(97)
    Y(109) = Y(83) * Y(95)
    Y(110) = Y(83) * Y(97)
    Y(111) = Y(84) * Y(96)
    Y(112) = Y(84) * Y(98)
    Y(113) = Y(83) * Y(96)
    Y(114) = Y(83) * Y(98)
    Y(115) = -Y(105) * Y(84)
    Y(116) = Y(105) * Y(83)
    Y(117) = -Y(78) * Y(116)
    Y(118) = -Y(103) * ( Y(84) * ( Y(109) * Y(93) + Y(111)+ Y(108))
   1 + Y(83) * ( Y(94) * Y(110) + Y(112)))
    Y(119) = Y(103) * ( Y(83) * (Y(94) * Y(109) + Y(111))-Y(84)
   1 * ( Y(110) * Y(93) + Y(112) - Y(107))) + Y(105) * Y(82)
    Y(120) = Y(104) * (Y(94) * Y(83) * Y(99) + Y(84) * Y(100))
   1+Y(106)*Y(119)-Y(105)*Y(82)*(Y(106)+Y(78))
    Y(121) = -Y(103) * ( Y(84) * (Y(94) * Y(107) - Y(113))
   1 + Y(83) * ( Y(108) * Y(93) + Y(109) - Y(114))) -Y(105) * Y(82)
    Y(122) = Y(103) * ( Y(83) * ( Y(107) * Y(93) - Y(113) -Y(110))
   1 - Y(84) * ( Y(94) * Y(108) - Y(114)))
    Y(123)=Y(104)*(Y(94)*Y(84)*Y(99)-Y(83)*Y(100))
   1 + Y(106) * Y(122)
    Y(124) = -Y(102) * ( Y(107) + Y(110)) + Y(115) * Y(82)
    Y(125) = Y(102) * (Y(109) -Y(108)) + Y(116) * Y(82)
    Y(126) = Y(102) * Y(79) * Y(90) * Y(99) + Y(106) * Y(125)
   1 + Y(117) * Y(82) - Y(106) * Y(116) *Y(82)
    SCY53=SIN(CY53)
    CCY53=COS(CY53)
    AA115=Y(115)
    AA116=Y(116)
    AA118=Y(118)
    AA119=Y(119)
    AA121=Y(121)
    AA122=Y(122)
    AA124=Y(124)
    AA125=Y(125)
    Y(115)=AA115*CCY53-AA116*SCY53
    Y(116)=AA116*CCY53+AA115*SCY53
    Y(118)=AA118*CCY53-AA119*SCY53
    Y(119)=AA119*CCY53+AA118*SCY53
    Y(121)=AA121*CCY53-AA122*SCY53
```

```
      Y(122)=AA122*CCY53+AA121*SCY53
      Y(124)=AA124*CCY53-AA125*SCY53
      Y(125)=AA125*CCY53+AA124*SCY53
      RETURN
  670 FORMAT (1HO,*Y(91) = *,E12.4,3X,*Y(92) = *,E12.4,3X,*Y(95) = *,E12.4)
  671 FORMAT(1H ,* Y(97)  = *,10E12.4)
  672 FORMAT(1H ,* Y(99)  = *,10E12.4)
      END
```

```
      SUBROUTINE NS1214(EMT,U,APHIJ,CLIFT,ASLOP,CMOME,CDRAG,CMSL,CDSL)
      COMMON/LINA/IINA,LAFI
C
C     SUBROUTINE TO COMPUTE CLIFT=LIFT COEFFICIENT
C                           ASLOP=LIFT CURVE SLOPE
C                           CMOME=MOMENT COEFFICIENT
C                           CDRAG=DRAG COEFFICIENT
C                           CMSL=MOMENT CURVE SLOPE
C                           CDSL=DRAG CURVE SLOPE
C     FORMULAS TAKEN FROM CURVE FITS BY P.C.
C
      CLIFT=0.
      ASLOP=0.
      CMOME=0.
      CDRAG=0.
      CMSL=0.
      CDSL=0.
C
  180 NEG=1
      EMIJ=EMT*ABS(U)
      SQT=SQRT(1.-EMIJ*EMIJ)
      C1=1.-EMIJ
      C2=.22689*C1
      IF (IINA.EQ.0) GO TO 97
      C2=C2*(1.0+.01*LAFI)
   97 IF(APHIJ) 181,182,182
  181 APHIJ=-APHIJ
      NEG=-1*NEG
  182 IF(APHIJ-3.1415926) 184,184,183
  183 APHIJ=APHIJ-3.1415926*2.
      GO TO 97
  184 IF(APHIJ-C2) 185,187,187
  185 ASLOP=5.7296/SQT
      CLIFT=ASLOP*APHIJ
      CDRAG=.006+.13131*APHIJ*APHIJ
      CMOME=0.0
      CMSL=0.0
      CDSL=.26262*APHIJ
      GO TO 250
  187 IF(APHIJ-.34906) 189,191,191
  189 CLIFT=.29269*C1+(1.3*EMIJ-.59)*APHIJ
      CMOME=0.0
      C2=(.12217+.22689*EMIJ)*SQT
      CLIFT=CLIFT/C2
      ASLOP=(1.3*EMIJ-.59)/C2
      CMSL=0.0
      GO TO 210
  191 IF(APHIJ-2.7402) 193,195,195
  193 S=SIN(APHIJ)
      S2=SIN(2.*APHIJ)
```

```
      S3=SIN(3.*APHIJ)
      S4=SIN(4.*APHIJ)
      CLIFT=(.080373*S+1.04308*S2-.011059*S3+.023127*S4)/SQT
      C=COS(APHIJ)
      C2=COS(2.*APHIJ)
      C3=COS(3.*APHIJ)
      C4=COS(4.*APHIJ)
      ASLOP=(.080373*C+2.08616*C2-.033177*C3+.092508*C4)/SQT
      CDRAG=(1.1233-.029894*C-1.00603*C2+.003115*C3-.091487*C4)/SQT
      CDSL=(.029894*S+2.01206*S2-.009345*S3+.365948*S4)/SQT
      CMOME=(-.02827*S+.14022*S2-.00622*S3+.01012*S4)/SQT
     1 -.25*(CLIFT*C+CDRAG*S)
      CMSL=(-.569865*C+.27335*C2-.028178*C3+.042466*C4+S*(.009263*S2
     1 -.003972*S3-.08545*S4))/SQT
      GO TO 250
  195 IF(APHIJ-3.0020) 197,199,199
  197 CLIFT=-(.4704+.10313*APHIJ)/SQT
      ASLOP=-.10313/SQT
      CMOME=-.3452984/SQT
      CMSL=0.
      GO TO 210
  199 IF(APHIJ-3.1415926) 200,200,260
  200 CLIFT=(-17.550+5.5864*APHIJ)/SQT
      ASLOP=5.5864/SQT
      CMOME=-.3452984*(1.0-((APHIJ-3.002)/.1395927))/SQT
      CMSL=.3452984/(.1395927*SQT)
  210 CDRAG=(1.1233-.029894*COS(APHIJ)-1.00603*COS(2.*APHIJ)
     1       +.003115*COS(3.*APHIJ)-.091487*COS(4.*APHIJ))/SQT
      CDSL=(.029894*SIN(APHIJ)+2.01206*SIN(2.*APHIJ)
     1       -.009345*SIN(3.*APHIJ)+.365948*SIN(4.*APHIJ))/SQT
  250 IF(NEG) 255,255,260
  255 CLIFT=-CLIFT
      CMOME=-CMOME
      APHIJ=-APHIJ
      CDSL=-CDSL
  260 CONTINUE
C
300   CONTINUE
      RETURN
      END
```

```
      SUBROUTINE PSYK(CPSY,SPSY,K,N1,CY19)
      COMPLEX CY19
      DIMENSION CPSY(24,20),SPSY(24,20)
      N =IABS(N1)
      IF(N1.EQ.0) GO TO 110
      A = CPSY(K,N)
      B = SPSY(K,N)
  110 IF(N1) 120,121,122
  120 CY19 = CMPLX(A,B)
      GO TO 123
  121 CY19 = CMPLX(1.0,0.0)
      GO TO 123
  122 CY19 = CMPLX(A,-B)
  123 CONTINUE
      RETURN
      END
```

```
      OVERLAY (NS6,1,0)
      PROGRAM DUMMY
      COMPLEX FKN(123)
      COMPLEX FASB(25),CTSB(25),FLSB(25),FLSC(25),FASD(25),CTSD(25),
     1FASC(25)
      COMPLEX B(1800),SMLB(300),SMLC(300),SMLD(300)
      COMPLEX FAB(150),FLB(150),CTB(150)
      COMPLEX H(60),CTH(5),FLH(5),FAH(5)
      COMMON/FKN1/FKN
      COMMON/BTS1/B,SMLB,SMLC,SMLD
      COMMON/BTS2/FAB,FLB,CTB
      COMMON/BTS3/FASB,CTSB,FLSB,FLSC,FASD,CTSD,FASC
      COMMON/RETS/H,CTH,FLH,FAH
      COMMON/NO7/I,J
      RETURN
      END
```

```
      OVERLAY(NS6,1,1)
      PROGRAM SETUP
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
C
C        COMMON AREAS
C
      COMMON/SWASH/SWGJ,SWEI,SWM,SWR
      COMMON/RNAME/CS(4,20),SN(4,20)
      COMMON/RNAME1/CS1(4,6),SN1(4,6)
      COMMON/SCTAB/CPSY(24,20),SPSY(24,20)
      COMMON/SAIN/SD(7425)
      COMMON/SUB/Y(225)
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/GYR/GYM,GYK,GYC,GKB,GCB,GKP,GCP,GRP,GIY,GIY,GIZ
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/CYM/CY54,CY55
      COMMON/IWA1/IWAKE,NAERO,MAERO
      COMMON/IWA2/ITI,NANR,IMAX,KTEST
      COMMON/IWA3/MXIT
      COMMON/IWA4/NN4,NN5,NN6
      COMMON/DIMS/NN1,NN2,NN3
      COMMON/IPH1/ NNFAZ,NNBS
      COMMON/IS1/NFF
      COMMON/NO1/MXCPK,MXKQ,MXSMP,MFASB,MXFAB
      COMMON/NO2/MXCSB,NESBC,MXCPM,NEBC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NFIFC,MXSMI,NFLAE,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO8/JYBO
      COMMON/IBRIG/MINPN,MAXPN
      COMMON/AERDM/DMS(4)
      COMMON/AERTP/AKT(4),ACT(4),AKP(4),ACP(4)
      COMMON/AERBP/BJ(4)
      COMMON/IFT/ITP
      COMMON/ISMB/MS
      COMMON/IH/IH34
      COMMON/CYM1/CY56,CY57
      COMMON/NGAT/NWFC,NP6,NTRT
      COMMON/LINA/IINA,LAFI
      COMMON/CYM2/CY58
      COMMON/NGAD/NHWI,NCVF,NPRS
```

```
      COMMON/VMAKE/VMAXI
C
      DATA BLANK,MINUS/1H ,1H-/
C
      NCUT = 6
      NSIZBY = 225
      READ(5,902)NP3,NP4,NP5,NP6,NTRT
      READ(5,902)NB,NSP,MAXN,NES,NF,MAERO,NAS,IGYRO,JYRO
      WRITE(6,910)
      IF(JYRO.EQ.0) GO TO 9
      IF(MAXN.LE.1) GO TO 9
      MAXN=1
      WRITE(6,907)
    9 CONTINUE
      IF(NP3.EQ.0) GO TO 13
      WRITE(6,912)NN1,NN2,NN3,NN4,NN5,NN6,NWFC,NHWI,NCVF,NPRS
      WRITE(6,913)IWAKE,NAERO,MXIT,KTEST,IH34
      WRITE(6,914)NP3,NP4,NP5,NP6,NTRT
      WRITE(6,916) NB,NSP,MAXN,NES,NF,MAERO,NAS,IGYRO,JYRO
   13 READ(5,902) NNFAZ,NNBS,NFF,IINA,LAFI
      IF(NP3.EQ.0) GO TO 14
      WRITE (6,919) NNFAZ,NNBS,NFF,IINA,LAFI
   14 NFP1=NF+1
      MXSMI=2*NF+1
      MXKQ=12*MXSMI
      READ(5,902)MFLAP,NFEA,NCT,NFLAP,NS,NBS,NPS,NET,NIG
      IF(NP3.EQ.0) GO TO 15
      WRITE(6,917) MFLAP,NFEA,NCT,NFLAP,NS,NBS,NPS,NET,NIG
   15 NCOLS = 6
      NCSB = 1
      READ(5,902) MINPN,MAXPN
      NP = MINPN
      IF(IWAKE.EQ.0) GO TO 19
      IF(MAERO.GT.0) GO TO 19
      WRITE(6,908)
      NP=MAXPN+1
      GO TO 210
   19 CONTINUE
      IF(NP3.EQ.0) GO TO 16
      WRITE(6,911) MINPN,MAXPN
C
C        COMPUTE ARRAY INDEXING VARIABLES
C
   16 NRBD = 8+MFLAP
      MXT2P1 = (2*MAXN+1)*NSP
      MXCSB = 12*NCSB
      MXCPM = 12*NCOLS
      MXCPL = MXSMI*MXSMI
      NRIFC = MXT2P1 + NB*NRBD
      MXCPK = MXCPL*MXCPM
```

```
      MXSMB = MXCPL*MXCSB
      MFASB = MXCPL*NCSB
      MXFAB = MXCPL*NCOLS
      NEIFC = NRIFC*MXT2P1
      NEISC = NRIFC*NRBD
      NEBC = MXCPM*MXSMI
      NESBC=MXCSB*MXSMI
      MXQ = NRIFC*MXSMI
      MXTKN = NEIFC+NB*NEISC
      READ(5,901)CY4,CY9,CY10,CY14,CY15,CY11,CY46,CY47,CY48,CY49,CY50,
     1CY54,CY55,CY56,CY58,VMAXI
      CY57=COS(CY56)
      CY56=SIN(CY56)
      IF(NP3.EQ.0) GO TO 17
      WRITE(6,921)
      WRITE(6,918)CY4,CY9,CY10,CY14,CY15,CY11,CY46,CY47,CY48,CY49,CY50,
     1CY54,CY55,CY56,CY58,VMAXI
C
C         READ IN SWASH-PLATE VARIABLES
C
   17 IF(NSP.EQ.0) GO TO 30
      IF(JYBO.EQ.1)GO TO 20
      READ(5,901) SWGJ,SWEI,SWM,SWR
      IF(NP4.EQ.0) GO TO 18
      WRITE(6,920) SWGJ,SWEI,SWM,SWR
   18 CALL SUPPHA
      READ(5,901) (AK(J),J=1,NES)
      READ(5,901) (AC(J),J=1,NES)
      READ(5,901) CAPK,CAPC
      READ(5,901) (AKT(J), J=1,NES)
      READ(5,901) (ACT(J), J=1,NES)
      READ(5,901) (AKP(J), J=1,NES)
      READ(5,901) (ACP(J), J=1,NES)
      READ(5,901) (BJ(J), J=1,NES)
      GO TO 30
   20 READ(5,901) GYM,GYK,GYC,GIX,GIY,GIZ,GKX,GKY,GCX,GCY,GRP
      IF(NP4.EQ.0) GO TO 22
      WRITE(6,922) GYM,GIX,GYK,GIY,GYC,GIZ,GKX,GKY,GCX,GCY,GRP
   22 GKB=.5*(GKX+GKY)
      GKP=.5*(GKX-GKY)
      GCB=.5*(GCX+GCY)
      GCP=.5*(GCX-GCY)
   30 IF (MAXN.GT.NF) GO TO 32
      ITP = 2*NF
      GO TO 34
   32 ITP=2*MAXN
   34 CALL PHASE
      READ(5,901) (DMS(MS), MS=1,NB)
      READ(5,901) (AKCI(MS), MS=1,NB)
      READ(5,901) (TAU(MS), MS=1,NB)
```

```
      READ(5,901) (SMLA(MS), MS=1,NB)
      CY2 = (0.,1.)
      CY7 = CY4*CY4
      CY8 = 2.0*CY4*IGYRO
      CY12 = 3.1415927
      CY13 = CY12*.25
      CY16 = SIN(CY15)
      CY17 = COS(CY15)
      CY18 = NAS
      CY40 = NS
      CY41 = NS
      CY42 = NFEA
      CY43 = NF
      CY44 = MXSMI
      CY45 = NP
      CY51 = COS(CY46)
      CY52 = SIN(CY46)
C
C        READ IN AND COMPUTE BLADE STATION DATA
C
      DO 40 I=1,NSIZEY
   40 Y(I)=0.
      IF(NP5.EQ.0) GO TO 11
      WRITE (6,955) (I,I=1,7)
   11 DO 209 MS=1,NB
      DO 120 J=1,NS
      READ(5,909)M1,M2,M3,M4,M5,M6,M7
      Y(201)=M1
      Y(202)=M2
      Y(203)=M3
      Y(204)=M4
      Y(205)=M5
      Y(206)=M6
      Y(207)=M7
      IF(M1.EQ.0) GO TO 10
      CALL YA(J)
      IF (NP5.EQ.0) GO TO 12
      I=1
      II=5
      WRITE(NOUT,956) J,M1,M2,M3,M4,M5,M6,M7,MINUS,I,Y(I),
     1 (BLANK,I,Y(I),I=2,4),MINUS,II,Y(II)
      WRITE(NOUT,957) (MINUS,I,Y(I),I=6,7),(BLANK,I,Y(I),I=8,10)
      WRITE(NOUT,957) (BLANK,I,Y(I),I=75,79)
      WRITE(NOUT,957) (BLANK,I,Y(I),I=180,182,2)
   12 IF(M2.EQ.0) GO TO 3
      CALL BYB(J)
      IF(NP5.EQ.0) GO TO 3
      WRITE(NOUT,957) (BLANK,I,Y(I),I=8,10)
    3 IF(M4.EQ.0) GO TO 5
      CALL BYE(J)
```

```
      IF(NP5.EQ.0) GO TO 5
      IF(M1.NE.0.OR.M2.NE.0) GO TO 4010
      I=150
      II=181
      WRITE(NOUT,956)J,M1,M2,M3,M4,M5,M6,M7,MINUS,I,Y(I),
     1 (BLANK,I,Y(I),I=151,154)
      WRITE(NOUT,957) BLANK,II,Y(II)
      GO TO 5
 4010 I=150
      II=181
      WRITE(NOUT,957) MINUS,I,Y(I),(BLANK,I,Y(I),I=151,154)
      WRITE(NOUT,957) BLANK,II,Y(II)
    5 IF(M5.EQ.0) GO TO 7
      CALL YRIGID
      WRITE(6,915)
      IF(NP5.EQ.0) GO TO 7
      IF(M1.NE.0.OR.M2.NE.0.OR.M4.NE.0) GO TO 6020
      WRITE(NOUT,956)J,M1,M2,M3,M4,M5,M6,M7,(MINUS,I,Y(I),I=184,186),
     1 (BLANK,I,Y(I),I=187,188)
      II=189
      WRITE(NOUT,957) BLANK,II,Y(II)
      GO TO 7
 6020 WRITE(NOUT,957) (MINUS,I,Y(I),I=184,186),(BLANK,I,Y(I),I=187,188)
      II=189
      WRITE(NOUT,957) BLANK,II,Y(II)
    7 IF(M6.EQ.0) GO TO 90
      CALL YSK
      IF(NP5.EQ.0) GO TO 90
      IF(M1.NE.0.OR.M2.NE.0.OR.M4.NE.0.OR.M5.NE.0) GO TO 8000
      II=196
      WRITE(NOUT,956)J,M1,M2,M3,M4,M5,M6,M7,(MINUS,I,Y(I),I=190,192),
     1 (BLANK,I,Y(I),I=193,194)
      I=195
      WRITE(NOUT,957) BLANK,I,Y(I),MINUS,II,Y(II)
      GO TO 90
 8000 II=196
      WRITE(NOUT,957)(MINUS,I,Y(I),I=190,192),(BLANK,I,Y(I),I=193,194)
      I=195
      WRITE(NOUT,957) BLANK,I,Y(I),MINUS,II,Y(II)
      GO TO 90
   10 IF(M2.EQ.0) GO TO 3
      CALL BYB(J)
      IF(NP5.EQ.0) GO TO 3
      IF(M1.NE.0) GO TO 2005
 2000 WRITE(NOUT,956) J,M1,M2,M3,M4,M5,M6,M7,(BLANK,I,Y(I),I=8,10)
      GO TO 3
 2005 WRITE(NOUT,957) (BLANK,I,Y(I),I=8,10)
      GO TO 3
   90 DO 200 L=1,NSIZEY
      M=(J-1)*NSIZEY+L
```

```
  200 SD(M)=Y(L)
      DO 203 I=1,NSIZEY
  203 Y(I)=0.
  120 CONTINUE
      IF(MAERO .EQ. 0) GO TO 206
      DO 119 K=1,NAS
      DO 119 L=1,NFF
      CPSY(K,L)=COS(L*((K-1)*(2.*CY12)/NAS))
  119 SPSY(K,L)=SIN(L*((K-1)*(2.*CY12)/NAS))
      CALL AEROM
  208 CONTINUE
C
C         STORE BLADE STATION DATA ON DISK
C
      WRITE (2) SD
  209 CONTINUE
      REWIND 2
      REWIND 3
  210 CONTINUE
      RETURN
C
  901 FORMAT (8F10.0)
  902 FORMAT (16I5)
  907 FORMAT(3X,*MAXN MUST BE .LE. 1 IF JYRO IS 1, MAXN IS RESET TO 1*)
  908 FORMAT(3X,*IF IWAKE = 1, THEN MAERO MUST BE INPUTTED AS 1*)
  909 FORMAT (8I1)
  910 FORMAT(1H1,50X,32HNASA HELICOPTER DYNAMIC RESPONSE/)
  911 FORMAT(32X,8H MINPN =,I3,11H     MAXPN =,I3)
  912 FORMAT(32X,8H   NN1 =,I4,10H      NN2 =,I4,10H      NN3 =,I3,
     1 11H       NN4 =,I3,11H       NN5 =,I3/32X,8H   NN6 =,I3,
     2 11H      NWFC =,I3,11H      NHWI =,I3,11H      NCVF =,I3,
     3 11H      NPRS =,I3)
  913 FORMAT(32X,8H IWAKE =,I3,11H     NAERO =,I3,11H      MXIT =,I3,
     1 11H     KTEST =,I3,11H      IH34 =,I3)
  914 FORMAT(32X,8H   NP3 =,I3,11H       NP4 =,I3,11H       NP5 =,I3,
     1 11H       NP6 =,I3,11H      NTRT =,I3)
  915 FORMAT(3X,*IF MAERO NOT = 0 RIGID SECTIONS MUST BE AVOIDED, MAERO
     1= 0 CENTRIFUGAL FORCE Y(187) MUST BE INPUTTED,*/3X,*SUGGEST USE OF
     2 STIFF ELASTIC SECTIONS INSTEAD*/)
  916 FORMAT(32X,8H    NB =,I3,11H       NSP =,I3,11H      MAXN =,I3,
     1 11H       NES =,I3,11H        NF =,I3,/32X,8H MAERO =,I3,
     2 11H       NAS =,I3,11H     IGYRO =,I3,11H      JYRO =,I3)
  917 FORMAT(32X,8H MFLAP =,I3,11H      NFEA =,I3,11H       NCT =,I3,
     1 11H     NFLAP =,I3,11H        NS =,I3,/32X,8H   NBS =,I3,
     2  11H       NPS =,I3,11H       NET =,I3,11H       NIG =,I3)
  918 FORMAT(3(/),29X,17HOPERATING SPEED =,F10.4,19X,
     1 16HSPEED OF SOUND =,F10.4/30X,16HDENSITY OF AIR =,
     2 F10.4,11X,24HAIRCRAFT FORWARD SPEED =,F10.4/28X,
     2 18HROTOR TILT ANGLE =,F10.4,17X,18HGRAVITY CONSTANT =,F10.4/40X,
     3 6HBETA =,F10.4,21X,14HALPHA CYCLIC =,F10.4/35X,11HROLL RATE =,
```

```
     4 F10.4,17X,18HCOLLECTIVE ANGLE =,F10.4/32X,14HROTOR RADIUS =,
     5 F10.4,21X,14HPULL UP RATE =,F10.4/32X,14HTURNING RATE =,F10.4,
     617X,18HSINE(BANK ANGLE) =,F10.4/33X,13HROOT LENGTH =,F10.4,
     719X,16HVEL(I,J) LIMIT =,F10.4)
919  FORMAT (32X,8H NNFAZ =,I3,11H      NNBS =,I3,11H       NFF =,I3,
     1 11H      IINA =,I3,11H      LAFI =,I3)
920  FORMAT(2(/),31X,15HSWASHPLATE GJ =,F10.2,20X,15HSWASHPLATE EI =,
     1 F10.2/29X,17HSWASHPLATE MASS =,F10.4,16X,19HSWASHPLATE RADIUS =,
     2 F10.4)
921  FORMAT(50X,27HHELICOPTER ROTOR PARAMETERS//)
922  FORMAT(2(/),35X,11HGYRO MASS =,F10.4,26X,9HGYRO IX =,F10.4/19X,
     1 27HCOLLECTIVE GYRO STIFFNESS =,F10.2,26X,9HGYRO IY =,F10.4/21X,
     2 25HCOLLECTIVE GYRO DAMPING =,F10.4,26X,9HGYRO IZ =,F10.4,/22X,
     3 24HLATERAL GYRO STIFFNESS =,F10.2,14X,21HLONG GYRO STIFFNESS =,
     4 F10.2/24X,22HLATERAL GYRO DAMPING =,F10.4,16X,
     5 19HLONG GYRO DAMPING =,F10.4/33X,13HGYRO RADIUS =,F10.4)
955  FORMAT(3(/),8H SECTION,7(2H M,I1),37X,21HINPUT Y VECTOR VALUES)
956  FORMAT(I5,3X,7I3,5(1X,A1,2HY(,I3,3H) =,E10.3))
957  FORMAT(29X,5(1X,A1,2HY(,I3,3H) =,E10.3))
     END
```

```
      SUBROUTINE SUPPHA
      REAL CHI(4)
      COMMON/RNAME1/CS1(4,6),SN1(4,6)
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
C
      READ(5,700)  (CHI(J), J=1,NES)
      IF(MAXN.EQ.0) GO TO 13
      MXNT2=2*MAXN
      DO 12 J=1,NES
      DO 12 NL=1,MXNT2
      ARG =NL*CHI(J)
      CS1(J,NL)=COS(ARG)
   12 SN1(J,NL)=SIN(ARG)
   13 RETURN
  700 FORMAT(8F10.6)
      END
```

```
      SUBROUTINE PHASE
      REAL PHIM(4),PHIMP(4)
      COMMON/RNAME/CS(4,20),SN(4,20)
      COMMON/IFT/ITP
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
C
      READ (5,700) (PHIM(MS), MS = 1,NB)
      READ (5,700) (PHIMP(MS), MS = 1,NB)
      IF (ITP.EQ.0) GO TO 11
      DO 10 MS = 1,NB
      DO 10 L=1,20
      ARG = L*(PHIM(MS)-PHIMP(MS))
      CS(MS,L) = COS(ARG)
   10 SN(MS,L) = SIN(ARG)
   11 RETURN
  700 FORMAT (8F10.6)
      END
```

```
      SUBROUTINE YA(IS)
C
C     YA-
C     MASS MATRIX FOR BLADE- ELEMENTS OF VECTOR -Y- TO BE CREATED.
C
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NBS,MAXN,NFP1
      COMMON/SUB/Y(225)
C
      READ (5,701)  (Y(I),I=1,10),(Y(K),K=75,79),Y(180),Y(182)
      IF(IS-NFEA) 590,600,600
  590 Y(10)=Y(10)+CY49
  600 Y(1) = -Y(1)
      Y(5) = -Y(5)
      Y(6) = -Y(6)
      Y(7) = -Y(7)
      Y(11) = SIN(Y(8))
      Y(12) = COS(Y(8))
      Y(13) = Y(11) * Y(11)
      Y(14) = Y(12) * Y(12)
      Y(15) = SIN(Y(9))
      Y(16) = COS(Y(9))
      Y(17) = Y(15) * Y(15)
      Y(18) = Y(16) * Y(16)
      Y(19) = SIN(Y(10))
      Y(20) = COS(Y(10))
      Y(21) = Y(19) * Y(19)
      Y(22) = Y(20) * Y(20)
      Y(23) = Y(11) * Y(12)
      Y(24) = Y(11) * Y(15)
      Y(25) = Y(11) * Y(16)
      Y(26) = Y(11) * Y(19)
      Y(27) = Y(11) * Y(20)
      Y(28) = Y(12) * Y(15)
      Y(29) = Y(12) * Y(16)
      Y(30) = Y(12) * Y(19)
      Y(31) = Y(12) * Y(20)
      Y(32) = Y(15) * Y(16)
      Y(33) = Y(15) * Y(19)
      Y(34) = Y(15) * Y(20)
      Y(35) = Y(16) * Y(19)
      Y(36) = Y(16) * Y(20)
      Y(37) = Y(19) * Y(20)
      Y(38) = Y(32) * Y(20)
      Y(39) = Y(32) * Y(19)
      Y(40) = Y(4) * Y(11) + Y(3) * Y(12)
      Y(41) = Y(3) * Y(11) - Y(4) * Y(12)
```

```
      Y(42) = Y(18) * (Y(22)-Y(21))
      Y(43) = Y(18) * Y(37)
      Y(44) = Y(18) * Y(21) + Y(17)
      Y(45) = Y(17) - Y(18) * Y(21)
      Y(46) = Y(18) * Y(22) +Y(17)
      Y(47) = Y(18) * Y(22) - Y(17)
      Y(48) = Y(1) * Y(2)
      Y(49) = Y(1) * Y(2) * Y(2)
      Y(50) = Y(5) + Y(49)
      Y(51) = Y(5) - Y(6)
      Y(52) = Y(5) - Y(7)
      Y(53) = Y(6) - Y(7)
      Y(54) = Y(51) + Y(49)
      Y(55) = -Y(53) + Y(49)
      Y(56) = Y(5) - Y(53) + (2. * Y(49))
      Y(57) = -Y(52) - Y(6)
      Y(58) = Y(7) - Y(51)
      Y(80) = 0.
      RETURN
  701 FORMAT (8F10.6)
      END
```

```
      SUBROUTINE BYB(IS)
C     BEND MATRIX-
C
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFFA,NES,MAXN,NFP1
      COMMON/SAIN/SD(7425)
      COMMON/SUB/Y(225)
C
      READ(5,912) Y(8),Y(9),Y(10)
      IF(Y(202).EQ.2.)GO TO 600
      IF(IS-NFEA) 590,600,600
  590 Y(10)=Y(10)+CY49
  600 IF(Y(201)-1.) 700,735,700
  700 Y(11) = SIN(Y(8))
      Y(12) = COS(Y(8))
      Y(15) = SIN(Y(9))
      Y(16) = COS(Y(9))
      Y(18) = Y(16) * Y(16)
      Y(19) = SIN(Y(10))
      Y(20) = COS(Y(10))
      CMMM11=ABS(Y(11))
      CMMM12=ABS(Y(12))
      CMMM15=ABS(Y(15))
      CMMM16=ABS(Y(16))
      CMMM19=ABS(Y(19))
      CMMM20=ABS(Y(20))
      IF(CMMM11 .LT. .1E-04) Y(11) =0.0
      IF(CMMM12 .LT. .1E-04) Y(12) =0.0
      IF(CMMM15 .LT. .1E-04) Y(15) =0.0
      IF(CMMM16 .LT. .1E-04) Y(16) =0.0
      IF(CMMM19 .LT. .1E-04) Y(19) =0.0
      IF(CMMM20 .LT. .1E-04) Y(20) =0.0
      Y(21) = Y(19) * Y(19)
      Y(22) = Y(20) * Y(20)
      Y(23) = Y(11) * Y(12)
      Y(24) = Y(11) * Y(15)
      Y(25) = Y(11) * Y(16)
      Y(26) = Y(11) * Y(19)
      Y(27) = Y(11) * Y(20)
      Y(28) = Y(12) * Y(15)
      Y(29) = Y(12) * Y(16)
      Y(30) = Y(12) * Y(19)
      Y(31) = Y(12) * Y(20)
      Y(33) = Y(15) * Y(19)
      Y(34) = Y(15) * Y(20)
      Y(35) = Y(16) * Y(19)
      Y(36) = Y(16) * Y(20)
```

```
735 I=(IS-2)*NSIZEY+11
    NSP1=NS+1
    IF (IS.EQ.1) GO TO 741
    IF(IS.EQ.NSP1) GO TO 741
739 Y(60) = SD(I)
    I = I+1
    Y(61) = SD(I)
    I = I+3
    Y(62) = SD(I)
    I = I+4
    Y(63) = SD(I)
    I = I+6
    Y(64) = SD(I)
    K = I + 6
    I=I+1
    M = 65
    DO 740  L = I,K
    Y(M) = SD(L)
740 M = M+1
    I=I+7
    Y(71) = SD(I)
    I=I+1
    Y(72) = SD(I)
    I=I+1
    Y(73) = SD(I)
    I=I+1
    Y(74) = SD(I)
    GO TO 742
741 Y(61) = 1.
    Y(68) = 1.
    Y(70) = 1.
    Y(74) = 1.
742 RETURN
912 FORMAT (3F10.6)
    END
```

```
      SUBROUTINE BYE(IS)
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFRA,NMS,MAXN,NFP1
      COMMON/SAIN/SD(7425)
      COMMON/SUB/Y(225)
C
      READ (5,701) (Y(I),I=150,154),Y(181)
      IF(Y(204)-1.) 650,648,651
  648 Y(150) = -Y(150)
  650 IF (Y(204)-1.) 9,9,11
    9 Y(154)=0.
      IF (IS .EQ. 1) GO TO 11
      ISM1=IS-1
      DO 10 J2=1,ISM1
      J2M1=(J2-1)*NSIZEY
   10 Y(154)=Y(154)-SD(J2M1+1)*SD(J2M1+3)*CY7
   11 Y(155) = -Y(150) * SQRT(Y(154) / Y(152))
      Y(156) = -Y(150) * SQRT(Y(154) / Y(153))
      Y(157) = SINH(Y(155))
      Y(158) = COSH(Y(155))
      Y(159) = SINH(Y(156))
      Y(160) = COSH(Y(156))
      Y(161) = Y(155) * Y(155)
      Y(162) = Y(161) * Y(161)
      Y(163) = Y(156) * Y(156)
      Y(164) = Y(163) * Y(163)
      IF (Y(155) -.01) 1570,1570,1550
 1550 Y(165) = Y(157) / Y(155)
      Y(166)=(Y(157)-Y(155))/(Y(161)*Y(155))
      Y(167) = Y(158)
      Y(168) = (Y(158) - 1.) / Y(161)
      IF (Y(156) -.01) 1580,1580,1560
C
C        VY.GT..1      VZ.GT.1
C
 1560 Y(169) = Y(159) / Y(156)
      Y(170) = ( Y(159) - Y(156)) / ( Y(156) * Y(163))
      Y(171) = Y(160)
      Y(172) = (Y(160) - 1.) / Y(163)
      GO TO 652
C
C     GAMMA Y )= .1
C
 1570 Y(165) = 1. + Y(161) / 6. + Y(162) / 120.
      Y(166) = .166666 + Y(161) / 120.+Y(162) / 5040.
      Y(167) = 1. + Y(161) / 2. + Y(162) / 24.
      Y(168) = .5 + Y(161) / 24. + Y(162) / 720.
```

```
      IF (Y(156) -.01) 1580,1580,1560
 1580 Y(169) = 1. + Y(163) / 6. + Y(164) / 120.
      Y(170) = .166666 + Y(163) / 120. + Y(164) / 5040.
      Y(171) = 1. + Y(163) / 2. + Y(164) / 24.
      Y(172) = .5 + Y(163) / 24. + Y(164) / 720.
      GO TO 652
  651 Y(158)=1.
      Y(160)=1.
      Y(165)=1.
      Y(166)=.1666666
      Y(167)=1.
      Y(168)=.5
      Y(169)=1.
      Y(170)=.1666666
      Y(171)=1.
      Y(172)=.5
  652 RETURN
  701 FORMAT (8F10.6)
      END
```

```
      SUBROUTINE YRIGID
C
C     THE   Y VALUES --184-186-- ARE DELTA X,Y,ANDZ
C
      COMMON/SUB/Y(225)
C
      READ (5,701) (Y(I),I=184,189)
      RETURN
  701 FORMAT (8F10.6)
      END
```

```
      SUBROUTINE YSK
C
C     -Y- VECTOR FOR STIFFNESS (SK) MATRIX
C
      COMMON/SUB/Y(225)
C
      READ (5,701) (Y(L),L=190,196)
C TO INVERT
      IF (Y(206)-1.) 79,78,79
   78 Y(190) = -Y(190)
      Y(191) = -Y(191)
      Y(192) = -Y(192)
      Y(196) = -Y(196)
   79 RETURN
  701 FORMAT (8F10.6)
      END
```

```
      CVFRLAY(NS6,1,2)
      PROGRAM LIFT
C
      REAL LIF(10,24)
      REAL LTH(10)
      REAL LTHMP
C
      COMMON /CYR/ CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/IAR1/IAR(10)
      COMMON/IWA1/IWAKE,NAERO,MAERO
      COMMON /NO5/ NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NMT,NPS
      COMMON /WA1/ GTEST
      COMMON/WA2/GAM(240)
      REAL GAMMA(10,24)
      COMMON/WA3/VZA1(13,33),VYA1(13,33),VZP1(13,33),VYP1(13,33)
      COMMON/WA4/ALPH1(10,24),VELF(10,24),LTH
      COMMON/IWA4/NN4,NN5,NN6
      COMMON/NGAD/NHWI,NCVF,NPRS
C
      IF (IAR(1).EQ.1) GO TO 5
      DO 6 K1=1,NAS
      ANGA=2.0*(K1-1)*CY12/NAS
      CY20=SIN(ANGA)
      CY21=COS(ANGA)
      CY53=-CY47*(CY21*CY51+CY20*CY52)
      CCY53=COS(CY53)
      SCY53=SIN(CY53)
      DO 6 I1=1,NAERO
      I2 = IAR(I1)
      I22 = I2-1
      CALP = COS(ALPH1(I1,K1))
      SALP=SIN(ALPH1(I1,K1))
      CALPA=CCY53*CALP+SCY53*SALP
      SALPA=CCY53*SALP-SCY53*CALP
      LIF(I1,K1)=(VZA1(1,I2)-VZA1(1,I22))*CALPA+
     1 (VYA1(1,I2)-VYA1(1,I22))*SALPA
      IF(NHWI.LE.0) GO TO 6
      DO 6 J1=1,NHWI
      J2=J1+1
      LIF(I1,K1)=LIF(I1,K1)+2.0*((VZA1(J2,I2)*COS(ANGA*J1+VZP1(J2,I2))
     1 -VZA1(J2,I22)*COS(ANGA*J1+VZP1(J2,I22)))*CALPA+
     2(VYA1(J2,I2)*COS(ANGA*J1+VYP1(J2,I2))
     3 -VYA1(J2,I22)*COS(ANGA*J1+VYP1(J2,I22)))*SALPA)
    6 CONTINUE
      IF (NN4 .EQ. 0) GO TO 30
      WRITE(6,103) ((LIF(I,J),I=1,NAERO),J=1,NAS)
      WRITE(6,104) ((VELF(I,J),I=1,NAERO),J=1,NAS)
```

```
 30 GDI=0.
    G=0.
    DO 21 I5=1,NAERO
    DO 21 J5=1,NAS
    K5=(J5-1)*NAERO+I5
 21 GAMMA(I5,J5)=GAM(K5)
    DO 3 I3=1,NAERO
    DO 3 K3=1,NAS
    X5=CY10*VELF(I3,K3)*LTH(I3)*CY4*CY50*CY50
    IF(X5.NE.0.0) GO TO 4
    LTEMP=0.0
    GO TO 9
  4 LTEMP=LIF(I3,K3)/X5
  9 GDIFF=LTEMP-GAMMA(I3,K3)
    GDI=GDI+ABS(GDIFF)
    GAMMA(I3,K3)=GAMMA(I3,K3)+.01*NCVF*GDIFF
    G=G+ABS(LTEMP)
  3 CONTINUE
    IF(G.GT..0000001) GO TO 10
    WRITE(6,905)
    GTEST=0.0
    GO TO 12
 10 GTEST=GDI/G
 12 IF(NN5.EQ.0) GO TO 31
    WRITE(6,102) ((GAMMA(I,J),I=1,NAERO),J=1,NAS)
102 FORMAT(* BOUND CIRCULATIONS */(8G14.5))
103 FORMAT(* LIFT ON BLADE */(8G14.5))
104 FORMAT(* FREE STREAM VELOCITIES */(8G14.5))
 31 DO 22 I6=1,NAERO
    DO 22 J6=1,NAS
    K6=(J6-1)*NAERO+I6
 22 GAM(K6)=GAMMA(I6,J6)
    RETURN
  5 WRITE (6,101)
101 FORMAT(104HCAERO MATRIX NOT PERMITTED BY CONVENTION AT BLADE TIP S
   1TATION, REDEFINE INPUT AND REPLACE BY MASS MATRIX)
905 FORMAT(3X,*CIRCULATIONS ARE LESS THAN .1E-05, GTEST SET = 0.0*/)
    STOP
    END
```

```
      OVERLAY(NS6,1,3)
      PROGRAM WAKE
C
      INTEGER H
C
      DIMENSION SIG(240)
C
      COMMON/VEL1/VEL(10,24)
      COMMON/WA2/GAM(240)
      COMMON/IWA1/IWAKE,NAERO,MAERO
      COMMON/IWA2/ITI,NANR,IMAX,KTEST
      COMMON/IWA4/NN4,NN5,NN6
      COMMON/NGAT/NWFC,NP6,NTRT
      COMMON /IWA3/ MXIT
      COMMON/VMAKE/VMAXI
C
C        IF FIRST TIME, READ GAMMAS OR SET TO CONSTANT
C
      MSET=0
      NONE=0
      N2=2*NAERO
      NP1=NAERO+1
      NAS=NANR/NAERO
      IF(ITI.GT.0) GO TO 3
      IF (KTEST.EQ.0) GO TO 1
      IF (ITI.EQ.0) READ (8) (GAM(K),K=1,NANR)
      GO TO 3
    1 IF(NWFC.EQ.0) GO TO 18
      READ(5,901) (GAM(K),K=1,NANR)
      GO TO 3
   18 DO 2 K=1,NANR
    2 GAM(K)=.02
C
C        LOOP OVER TOTAL NUMBER OF AERODYNAMIC POINTS
C
    3 DO 8 K=1,NANR
      READ (9) MSET,(SIG(M),M=1,NANR)
      GO TO 6
C
C        COMPUTE INDEX VARIABLES FOR MATRIX MULT
C
    6 J=(MSET-1)/NAERO+1
      I=J*NAERO+1-MSET
C
C        DO MATRIX MULT, WHERE H ORDERS THE GAMMAS
C
      SUM=0.
      DO 7 M=1,NANR
      H=N2*((M-1)/NAERO)+NP1-M
      IF(NWFC.EQ.1) GO TO 7
```

```
      IF (ITI.EQ.0) H=M
    7 SUM=SIG(M)*GAM(H)+SUM
      NONE=1
C
C        SET I,J INDUCED VELOCITY FOR NEXT ITERATION
C
      VEL(I,J)=-SUM
      IF(VMAXI.EQ.0.0) GO TO 8
      VABS=ABS(VEL(I,J))
      IF(VABS.GT.VMAXI) VEL(I,J)=VEL(I,J)*VMAXI/VABS
    8 CONTINUE
      IF(NN4 .EQ. 0) GO TO 21
      WRITE(6,108) (GAM(N),N=1,NANR)
  108 FORMAT(* GAMMA FROM WAKE */(8G14.5))
   21 IF(ITI.NE.MXIT) GO TO 19
      IF(NP6.EQ.0) GO TO 19
      WRITE(4,901) (GAM(K),K=1,NANR)
   19 CONTINUE
      WRITE(6,101) ((VEL(I,J),I=1,NABEO),J=1,NAS)
  101 FORMAT(* INDUCED VELOCITIES FROM WAKE */(8G14.5))
  901 FORMAT(5G16.7)
      IF (KTEST.NE.0) REWIND 8
      REWIND 9
      RETURN
      END
```

```
      OVERLAY(NS6,1,4)
      PROGRAM PARRAY
C
      INTEGER CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      INTEGER FAM(4),EM(6)
      REAL RREAL(144)
      REAL VZA1(13,33),VYA1(13,33),VZP1(13,33),VYP1(13,33)
C
      COMPLEX AMA(1700)
      COMPLEX AMF(1230)
      COMPLEX TH(72),FP(12),R(144),T(72),D(144),C(144)
      COMPLEX B(1800),H(60),SMLB(300),SMLC(300),SMLD(300)
      COMPLEX FAB(150),FLB(150),CTB(150)
      COMPLEX FAH(5),FLH(5),CTH(5)
      COMPLEX FASB(25),CTSB(25),FLSB(25),FLSC(25),FASD(25),CTSD(25)
      COMPLEX BSAVE(1800),HSAVE(60),SMLBSV(300),SMLCSV(300)
      COMPLEX SMLDSV(300),SHAPE(12)
      COMPLEX EPS(123),DETSV
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX FASC(25)
      COMPLEX EXPOB(5)
C
      COMMON/AMFT/AMF
      COMMON/AMAT/AMA
      COMMON/SUB/Y(225)
      COMMON/EPSA/EPS,DETSV
      COMMON/BTS1/B,SMLB,SMLC,SMLD
      COMMON/BTS2/FAB,FLB,CTB
      COMMON/BTS3/FASB,CTSB,FLSB,FLSC,FASD,CTSD,FASC
      COMMON/RETS/H,FAH,FLH,CTH
      COMMON/IPH1/NNFAZ,NNBS
      COMMON/IS1/NFF
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/ISMB/MS
      COMMON/NO1/MXCPK,MXKQ,MXSMB,MFASB,MXFAB
      COMMON/NO2/MXCSB,NESBC,MXCPM,NEBC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAE,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO8/JYBO
      COMMON/WA1/CONVG
      COMMON/WA5/ALLI
      COMMON/IWA2/ITI,NANR,IMAX,KTEST
      COMMON/IWA3/MXIT
```

```
      COMMON/SAIN/SD(7425)
C
      COMMON/IWA1/IWAKE,NAERO,MAERO
      COMMON/WA3/VZA1,VYA1,VZP1,VYP1
      COMMON/RNAME/CS(4,20),SN(4,20)
      COMMON/NGAD/NHWI,NCVF,NPRS
C
C
      DATA EM/1,15,29,42,57,70/
      DATA FAM/4,8,12/
C
      MXNFF=NFF*2+1
      NSD=NS*NSIZEY
      READ(2) SD
      NCCT=1
      NCFEA=1
      NCFLP=1
      IL=0
    5 DO 20 L=1,MXKQ
   20 H(L)=CMPLX(0.,0.)
      DO 15 L=1, MXSMB
      SMLB(L)=CMPLX(0.,0.)
      SMLC(L)=CMPLX(0.,0.)
   15 SMLD(L)=CMPLX(0.,0.)
      DO 22 K=1,MXCPK
   22 B(K)=(0.,0.)
      DO 30 I=1,MXSMI
      L=(I-1)*MXSMI+I
      K=L*MXCSB-9
      SMLC(K)=(1.,0.)
      K=K+1
      SMLB(K)=(1.,0.)
      K=K+6
      SMLD(K)=(1.,0.)*MFLAP
      LM1=(L-1)*MXCPM
      DO 30 M=1,6
      K=LM1+EM(M)
   30 B(K)=(1.,0.)
      DO 817 I=1,MFASB
      K=(I-1)*12+3
  817 FASC(I)=SMLC(K)
      IF(MFP.EQ.0) GO TO 14
      DO 13 JX=1,MXSMI
      LX=JX-NP-NFP1
      LXA=IABS(LX)
      IF(LX) 11,10,12
   10 EXPOB(JX)=(1.,0.)
      GO TO 13
   11 U1=CS(MS,LXA)
      U2=SN(MS,LXA)
```

```
      EXPOB(JX)=CMPLX(U1,-U2)
      GO TO 13
   12 U1=CS(MS,LX)
      U2=SN(MS,LX)
      EXPOB(JX)=CMPLX(U1,U2)
   13 CONTINUE
   14 CONTINUE
      DO 501 IS=1,NS
      ISM1=     (IS-1)*NSIZEY
      NCPLX=1
      DO 50 L=1,NSIZEY
      M=ISM1+L
   50 Y(L)=SD(M)
      IF(Y(205))80,80,55
   55 CALL RIGID (RREAL)
      LGO=1
   60 DO 79 I=1,MXSMI
      IM1=(I-1)*12
   51 DO 61 M=1,12
      K=IM1+M
   61 TH(M)=H(K)
      GO TO (62,63),NCPLX
   62 CALL MLRC1(RREAL,TH)
      GO TO 64
   63 CALL MLCC1(R,TH)
   64 DO 65 M=1,12
      K=IM1+M
   65 H(K)=TH(M)
   52 DO 79 J=1,MXSMI
      L=(J-1)*MXSMI+I
      LM1=(L-1)*MXCPM
      DO 66 M=1,MXCPM
      K=LM1+M
   66 T(M)=B(K)
      GO TO (67,68), NCPLX
   67 CALL MLRC2 (RREAL,T,NCOLS)
      GO TO 69
   68 CALL MLCC2 (R,T,NCOLS)
   69 DO 70 M=1,MXCPM
      K=LM1+M
      B(K)=T(M)
   70 CONTINUE
      GO TO (77,71),NCFIA
   71 LBM1=(L-1)*MXCSB
      DO 72 M=1,MXCSB
      K=LBM1+M
   72 TH(M)=SMLC(K)
      GO TO (73,74),NCPLX
   73 CALL MLRC2(RREAL,TH,NCSB)
      GO TO 75
```

```
 74 CALL MLCC2(R,TH,NCSB)
 75 DO 76 M=1,MXCSB
    K=LBM1+M
 76 SMLC(K)=TH(M)
 77 GO TO (78,711),NCCT
711 LBM1=(L-1)*MXCSB
    DO 721 M=1,MXCSB
    K=LBM1+M
721 TH(M)=SMLB(K)
    GO TO (731,741),NCPLX
731 CALL MLRC2(RREAL,TH,NCSB)
    GO TO 751
741 CALL MLCC2(R,TH,NCSB)
751 DO 761 M=1,MXCSB
    K=LBM1+M
761 SMLB(K)=TH(M)
 78 GO TO (79,712),NCFLP
712 LBM1=(L-1)*MXCSB
    DO 722 M=1,MXCSB
    K=LBM1+M
722 TH(M)=SMLD(K)
    GO TO (732,742),NCPLX
732 CALL MLRC2(RREAL,TH,NCSB)
    GO TO 752
742 CALL MLCC2(R,TH,NCSB)
752 DO 762 M=1,MXCSB
    K=LBM1+M
762 SMLD(K)=TH(M)
 79 CONTINUE
    GO TO (80,100,120),LGO
 80 IF(Y(202)) 100,100,85
 85 CALL BEND (RREAL)
    LGO=2
    GO TO 60
100 IF(Y(204)) 120,120,102
102 CALL ELAST(R)
    LGO=3
    NCPLX=2
    GO TO 60
120 DO 200 I=1,MXSMI
    IM1=(I-1)*12
    KSML=I-NFP1
    CY3=KSML
    CY5=CY1-CY2*CY3*CY4
    CY6=CY5*CY5
    KMNP=KSML-NP
    IF(Y(206)) 145,145,125
125 CALL STIFF (R,CY5)
    LGO=1
130 DO 132 M=1,12
```

```
      K=IM1+M
  132 TH(M)=H(K)
      CALL MLCC1(R,TH)
      DO 135 M=1,12
      K=IM1+M
  135 H(K)=TH(M)
  127 DO 404 J=1,MXSMI
      L=(J-1)*MXSMI+I
      LM1=(L-1)*MXCPM
      DO 136 M=1,MXCPM
      K=LM1+M
  136 T(M)=B(K)
      CALL MLCC2 (R,T,NCOLS)
      DO 137 M=1,MXCPM
      K=LM1+M
      B(K)=T(M)
  137 CONTINUE
      GO TO (142,138),NCFEA
  138 LBM1=(L-1)*MXCSB
      DO 139 M=1,MXCSB
      K=LBM1+M
  139 TH(M)=SMLC(K)
      CALL MLCC2(R,TH,NCSB)
      DO 140 M=1,MXCSB
      K=LBM1+M
  140 SMLC(K)=TH(M)
  142 CONTINUE
      GO TO (400,401),NCFLP
  401 LBM1=(L-1)*MXCSB
      DO 402 M=1,MXCSB
      K=LBM1+M
  402 TH(M)=SMLD(K)
      CALL MLCC2(R,TH,NCSB)
      DO 403 M=1,MXCSB
      K=LBM1+M
  403 SMLD(K)=TH(M)
  400 CONTINUE
      GO TO (404,405),NCCT
  405 LBM1=(L-1)*MXCSB
      DO 406 M=1,MXCSB
      K=LBM1+M
  406 TH(M)=SMLB(K)
      CALL MLCC2 (R,TH,NCSB)
      DO 407 M=1,MXCSB
      K=LBM1+M
  407 SMLB(K)=TH(M)
  404 CONTINUE
  144 GO TO (145,171), LGO
  145 IF(Y(201)) 200,200,150
  150 CY18A=-KMNP
```

```
 165 CALL MASSB(R,FP)
     LGO=2
     GO TO 130
 171 DO 180 M=1,12
     K=IM1+M
 180 H(K)=H(K)+FP(M)
 200 CONTINUE
     IF(Y(203)) 204,305,204
 204 IF(IL.GT.0) GO TO 209
     IF (IWAKE .EQ. 0) GO TO 201
     READ(3) AMF
     GO TO 209
 201 READ(3) AMA,AMF
 209 IL=IL+1
     GO TO (2141,210),NCFEA
 210 DO 214 K=1,MXSMB
     SMLCSV(K)=SMLC(K)
 214 SMLC(K)=(0.,0.)
2141 GO TO (2142,211),NCFLP
 211 DO 212 K=1,MXSMB
     SMLDSV(K)=SMLD(K)
 212 SMLD(K)=(0.,0.)
2142 GO TO (2143,281),NCCT
 281 DO 282 K=1,MXSMB
     SMLBSV(K)=SMLP(K)
 282 SMLB(K)=(0.,0.)
2143 DO 215 K=1,MXCPK
     BSAVE(K)=B(K)
 215 B(K)=(0.,0.)
     DO 216 K=1,MXKQ
     HSAVE(K)=H(K)
 216 H(K)=(0.,0.)
     NTIMS=MXSMI+1
     DO 300 NQ=1,NFP1
     CY18A=NQ-1
     NTIMS = NTIMS-1
     NSHFT=NQ-NFP1-1
     NBACK=1
 217 CALL AMROB(C,D,FP,IL)
     DO 250 JQ=1,NTIMS
     NSHFT=NSHFT+1
     CY3=NSHFT
 219 IQ=JQ+NQ-NBACK
     I=JQ+NBACK-1
     IQM1=(IQ-1)*12
     IM1=(I-1)*12
     CY5=CY1-CY2*CY4*NSHFT
     DO 220 M=1,144
 220 R(M)=CY5*C(M)+D(M)
     DO 225 M=1,12
```

```
      K=IQM1+M
  225 TH(M)=HSAVE(K)
      CALL MLCC1(R,TH)
      DO 228 M=1,12
      K=IM1+M
  228 H(K)=TH(M)+H(K)
      IF(NSHFT .NE. 0) GO TO 235
      KK=(IL-1)*MXNFF*3+(NP+NFP1-I+NFF)*3
      DO 230 M=1,3
      K=(I-1)*12+FAM(M)
  230 H(K)=H(K)+AMF(KK+M)
  235 DO 250 J=1,MXSMI
      L=(J-1)*MXSMI+I
      LQ=(J-1)*MXSMI+IQ
      LM1=(L-1)*MXCPM
      LQM1=(LQ-1)*MXCPM
      DO 240 M=1,MXCPM
      K=LQM1+M
  240 T(M)=BSAVE(K)
      CALL MLCC2 (R,T,NCOLS)
      DO 245 M=1,MXCPM
      K=LM1+M
  245 B(K)=T(M)+B(K)
      GO TO (249,246), NCFEA
  246 LBQ=(LQ-1)*MXCSB
      LB=(L-1)*MXCSB
      DO 247 M=1,MXCSB
      K=LBQ+M
  247 TH(M)=SMLCSV(K)
      CALL MLCC2(R,TH,NCSB)
      DO 248 M=1,MXCSB
      K=LB+M
  248 SMLC(K)=TH(M)+SMLC(K)
  249 GO TO (231,261),NCFLP
  261 LBQ=(LQ-1)*MXCSB
      LB=(L-1)*MXCSB
      DO 262 M=1,MXCSB
      K=LBQ+M
  262 TH(M)=SMLDSV(K)
      CALL MLCC2(R,TH,NCSB)
      DO 263 M=1,MXCSB
      K=LB+M
  263 SMLD(K)=TH(M)+SMLD(K)
  231 GO TO (250,232),NCCT
  232 LBQ=(LQ-1)*MXCSB
      IB=(L-1)*MXCSB
      DO 233 M=1,MXCSB
      K=LBQ+M
  233 TH(M)=SMLBSV(K)
      CALL MLCC2(R,TH,NCSB)
```

```
      DO 234 M=1,MXCSB
      K=LB+M
  234 SMLB(K)=TH(M)+SMLB(K)
  250 CONTINUE
  251 CONTINUE
      IF(NQ-1) 300,300,255
  255 GO TO (256,300),NBACK
  256 CY18A=-CY18A
      NBACK=2
      NSHFT=-NFP1
      GO TO 217
  300 CONTINUE
  305 CONTINUE
      IF(MFP .EQ. 1) GO TO 350
      IF (IS-NFBA) 326,310,326
  310 NCFBA=2
      DO 320 I=1,MXFAB
      K=(I-1)*12+4
  320 FAB(I)=B(K)
      DO 321 I=1,MXSMI
      K=(I-1)*12+4
  321 FAH(I)=H(K)
  312 IF (IS-NCT) 323,322,322
  322 DO 324 I=1,MFASB
      K=(I-1)*12+4
  324 FASB(I)=SMIB(K)
  323 IF (IS-NFLAP) 326,325,325
  325 DO 327 I=1, MFASB
      K=(I-1)*12+4
  327 FASD (I)=SMLD(K)
  326 CONTINUE
      IF (IS-NCT) 340,328,340
  328 NCCT=2
      DO 329 I=1,MXFAB
      K=(I-1)*12+3
  329 CTB(I)=B(K)
      DO 330 I=1,MXSMI
      K=(I-1)*12+3
  330 CTH(I)=H(K)
      DO 331 I=1,MFASB
      K=(I-1)*12+4
  331 CTSB(I)=SMLB(K)
      IF(IS-NFLAP) 333,332,332
  332 DO 334 I=1,MFASB
      K=(I-1)*12+3
  334 CTSD(I)=SMLD(K)
  333 CONTINUE
  340 IF (IS-NFLAP) 500,335,500
  335 NCFLP=2
      DO 336 I=1,MXFAB
```

```
      K=(I-1)*12+11
  336 FLB(I)=B(K)
      DO 337 I=1,MXSMI
      K=(I-1)*12+11
  337 FLH(I)=H(K)
  316 IF(IS-NCT) 339,338,338
  338 DO 342 I=1,MFASB
      K=(I-1)*12+11
  342 FLSB(I)=SMLB(K)
  339 IF(IS-NFEA) 500,343,343
  343 DO 344 I=1,MFASB
      K=(I-1)*12+11
  344 FLSC(I)=SMLC(K)
      GO TO 501
  350 IF(IS.EQ.NFEA) NCFEA=2
      IF(IS.EQ.NFLAP) NCFLP=2
      IF(IS.EQ.NCT) NCCT=2
      IB=1
      IF(NCT .GT. IS) IB=0
      IC=1
      IF (NFEA .GT. IS) IC=0
      ID=1
      IF(NFLAP .GT. IS) ID=0
      DO 351 IR=1,12
  351 SHAPE(IR)=CMPLX(0.,0.)
      J3=NF*72
      J2=NF*12
      J1=MXT2P1+(MS-1)*NRBD
  357 DO 366 J=1,MXSMI
      JM1=J-1
      IJ1=JM1*NEBC+J3
      IJ2=JM1*NESBC+J2
      IK1=JM1*NRIFC+J1
      DO 366 IR=1,12
      K=IJ1+IR
      L=IJ2+IR
      SHAPE(IR)=SHAPE(IR)-IC*SMLC(L)*EPS(IK1+7)*EXPOB(J)-IB*SMLB(L)*
     1EXPOB(J)*EPS(IK1+8)
      IF(ID .EQ. 0) GO TO 367
      SHAPE(IR)=SHAPE(IR)-ID*SMLD(L)*EPS(IK1+9)*EXPOB(J)
  367 DO 366 IP=1,6
      L1=IK1+IP
      K1=K+(IP-1)*12
  366 SHAPE(IR)=SHAPE(IR)+B(K1)*EPS(L1)*EXPOB(J)
      DO 368 IR=1,12
      L3=J2+IR
  368 SHAPE(IR)=SHAPE(IR)+H(L3)
      IF(IWAKE .EQ. 0) GO TO 4
      IF(MS.GT.1) GO TO 4
      IF(NP.GT.0) GO TO 2
```

```
      VYA1(1,IS)=-REAL(SHAPE(8))
      VZA1(1,IS)=REAL(SHAPE(12))
      VYP1(1,IS)=0.0
      VZP1(1,IS)=0.0
      GO TO 4
    2 MNP1=NP+1
      VYA1(MNP1,IS)=-CABS(SHAPE(8))
       VZA1(MNP1,IS)=CABS(SHAPE(12))
      X1=REAL(SHAPE(8))
      X2=AIMAG(SHAPE(8))
      X3=REAL(SHAPE(12))
      X4=AIMAG(SHAPE(12))
      VYP1(MNP1,IS)=0.0
      VZP1(MNP1,IS)=0.0
      IF(X1.EQ.0. .AND.X2.EQ.0.) GO TO 3
      VYP1(MNP1,IS)=ATAN2(X2,X1)
    3 IF(X3.EQ.0. .AND.X4.EQ.0.) GO TO 4
      VZP1(MNP1,IS)=ATAN2(X4,X3)
    4 CONTINUE
  499 CONTINUE
      IF(IWAKE .EQ. 0) GO TO 603
      IF(NPRS.NE.0) GO TO 603
      IF(ITI-MXIT) 500,603,603
  603 IF(MS.GT.1) GO TO 808
      IF(IS.GT.1) GO TO 809
      MM1=NF*NRIFC+1
      MM2=MM1+MXT2P1-1
      IF(NSP .EQ. 0) GO TO 808
      WRITE(6,950)
      IF(JYRO .EQ. 1) GO TO 804
      IF(MAXN-1) 801,802,803
  801 WRITE(6,951) (EPS(IEP),IEP=MM1,MM2)
      GO TO 808
  802 WRITE(6,952) (EPS(IEP),IEP=MM1,MM2)
      GO TO 808
  803 WRITE(6,953) (EPS(IEP),IEP=MM1,MM2)
      GO TO 808
  804 IF(MAXN.EQ.1) GO TO 806
  805 WRITE(6,954) (EPS(IEP),IEP=MM1,MM2)
      GO TO 808
  806 WRITE(6,955) (EPS(IEP),IEP=MM1,MM2)
  808 IF(IS.GT.1) GO TO 809
      WRITE(6,961) MS
  809 WRITE(6,901) IS
      WRITE(6,910) (SHAPE(IR),IR=1,12)
  500 CONTINUE
  501 CONTINUE
      RETURN
  901 FORMAT(//59X,11HSECTION I =,I3)
  950 FORMAT(/55X,22HSWASHPLATE DEFLECTIONS/)
```

```
951 FORMAT(/6X,*W(0) =*,2(1PE12.4)/)
952 FORMAT(/5X,*W(-1) =*,2(1PE12.4),6X,*W(0) =*,2(1PE12.4),5X,
   1*W(+1) =*,2(1PE12.4)/)
953 FORMAT(/5X,*MAXN .GT. 1, W(I) WHERE I GOES FROM -MAXN TO +MAXN*/
   2(2X,10PE13.4))
954 FORMAT(/6X,*Z(0) =*,2(1PE12.4)/)
955 FORMAT(/5X,*PHIXR =*,2(1PE12.4),6X,*Z(0) =*,2(1PE12.4),
   15X,*PHIYR =*,2(1PE12.4)/)
961 FORMAT(//51X,29HSTATE VECTORS ON BLADE NUMBER,I3)
910 FORMAT(/16X,*UX =*,2(1PE12.4),6X,*N =*,2(1PE12.4),3X,
   1*PHI X =*,2(1PE12.4)/17X,*T =*,2(1PE12.4),5X,*UY =*,
   22(1PE12.4),3X,*PHI Z =*,2(1PE12.4)/16X,*MZ =*,2(1PE12.4),
   34X,*-VY =*,2(1PE12.4),5X,*-UZ =*,2(1PE12.4)/13X,
   4*PHI Y =*,2(1PE12.4),5X,*MY =*,2(1PE12.4),6X,
   5*VZ =*,2(1PE12.4)/)
    END
```

```
      SUBROUTINE BEND (B)
C
C     Y(60) THRU Y(74) = PREVIOUS STATION DATA ARRAY VALUES
C
      REAL B(144)
      DIMENSION SA(3,3),SAT(3,3),SB(3,3)
      COMMON /SUB/ Y(225)
C
      SA(1,1) = Y(29)
      SA(1,2) = Y(25)
      SA(1,3) = -Y(15)
      SA(2,1) = Y(19) * Y(28) -Y(27)
      SA(2,2) = Y(33) * Y(11) + Y(31)
      SA(2,3) = Y(35)
      SA(3,1) = Y(34) * Y(12) + Y(26)
      SA(3,2) = Y(34) * Y(11) -Y(30)
      SA(3,3) = Y(36)
      SAT(1,1) = Y(68)
      SAT(1,2) = Y(63) * Y(67) - Y(66)
      SAT(1,3) = Y(72) * Y(61) + Y(65)
      SAT(2,1) = Y(64)
      SAT(2,2) = Y(71) * Y(60) + Y(70)
      SAT(2,3) = Y(72) * Y(60)- Y(69)
      SAT(3,1) = -Y(62)
      SAT(3,2) = Y(73)
      SAT(3,3) = Y(74)
      DO 20 I=1,3
      DO 20 J=1,3
      SB(I,J)=0.0
      DO 20 K=1,3
   20 SB(I,J)=SB(I,J)+SA(I,K)*SAT(K,J)
      DO 5 I=1,144
    5 B(I)=0.
   11 B(1)   = SB(1,1)
      B(5)   = SB(1,2)
      B(9)   =-SB(1,3)
      B(14)  = SB(1,1)
      B(20)  =-SB(1,2)
      B(24)  = SB(1,3)
      B(27)  = SB(1,1)
      B(30)  = SB(1,3)
      B(34)  = SB(1,2)
      B(40)  = SB(1,1)
      B(43)  = SB(1,3)
      B(47)  = SB(1,2)
      B(49)  = SB(2,1)
      B(53)  = SB(2,2)
      B(57)  =-SB(2,3)
      B(63)  = SB(3,1)
      B(66)  = SB(3,3)
```

```
B(70)  = SB(3,2)
B(76)  = SB(3,1)
B(79)  = SB(3,3)
B(83)  = SB(3,2)
B(86)  =-SB(2,1)
B(92)  = SB(2,2)
B(96)  =-SB(2,3)
B(97)  =-SB(3,1)
B(101) =-SB(3,2)
B(105)= SB(3,3)
B(111) = SB(2,1)
B(114)= SB(2,3)
B(118)= SB(2,2)
B(124)= SB(2,1)
B(127) = SB(2,3)
B(131)= SB(2,2)
B(144) = SB(3,3)
B(134)= SB(3,1)
B(140) =-SB(3,2)
RETURN
END
```

```
      SUBROUTINE ELAST (E)
C
C           ELASTIC MATRIX FROM -Y- VECTOR
C
      COMPLEX E(144)
      COMMON /SUB/ Y(225)
C
      DO 5 I=1,144
    5 E(I)=(0.,0.)
 1590 DO 1600  K=1,144,13
 1600 E(K) = 1.
      E(28) = Y(150) / Y(151)
      E(54) = Y(150) * Y(165)
      E(55) = Y(150) * Y(150) / Y(152) * Y(168)
      E(56) = Y(150) * Y(150) * Y(150) / Y(152) * Y(166)
      E(66) = Y(167)
      E(67) = Y(150) / Y(152) * Y(165)
      E(68) = Y(150) * Y(150) / Y(152) * Y(168)
      E(78) = Y(154) * Y(150) * Y(165)
      E(79) = Y(167)
      E(80) = Y(150) * Y(165)
      E(106) = Y(150) * Y(169)
      E(107) = Y(150) * Y(150) / Y(153) * Y(172)
      E(108) = Y(150) * Y(150) * Y(150) / Y(153) * Y(170)
      E(118) = Y(171)
      E(119) = Y(150) / Y(153) * Y(169)
      E(120) = Y(150) * Y(150) / Y(153) * Y(172)
      E(130) = Y(154) * Y(150) * Y(169)
      E(131) = Y(171)
      E(132) = Y(150) * Y(169)
      RETURN
      END
```

```
      SUBROUTINE RIGID(R)
      REAL R(144)
      COMMON/SUB/Y(225)
C
      DO 5  L=1,144
    5 R(L) = 0.
      IF (Y(205)-1) 80,79,80
   79 Y(184) = -Y(184)
      Y(185) = -Y(185)
      Y(186) = -Y(186)
   80 DO 10  L= 1,144,13
   10 R(L) = 1.
      R(6)    =-Y(185)
      R(10)   = Y(186)
      R(44)   =-Y(186)
      R(48)   =-Y(185)
      R(51)   =-Y(186)
      R(54)   = Y(184)
      R(74)   = Y(185)
      R(80)   = Y(184)
      R(99)   =-Y(185)
      R(106)  = Y(184)
      R(122)  =-Y(186)
      R(132)   =Y(184)
      R(39)  = +(Y(186)*Y(189)+Y(185)* Y(188))
      R(42) =-Y(184)*Y(189)
      R(46) =-Y(184)*Y(188)
      R(75) =-Y(186)*Y(187)
      R(78)  = +(Y(185) * Y(188) + Y(184) * Y(187))
      R(82)  =-Y(186)*Y(188)
      R(123)  =-Y(185) * Y(187)
      R(126)  =-Y(185) * Y(189)
      R(130)  = +(Y(184) * Y(187) + Y(186) * Y(189))
      RETURN
      END
```

```
      SUBROUTINE STIFF(SK,CY5)
      COMPLEX CY5
      COMPLEX SK(144)
      COMMON /SUB/ Y(225)
C
      DO 5 I=1,144
    5 SK(I)=(0.,0.)
      IF(Y(196)) 198,199,198
  198 SK(39) = Y(196)
      GO TO 200
  199 SK(28) = Y(190) / (1.+ Y(193) * CY5)
      SK(67) = Y(192) / (1. + Y(195) * CY5)
      SK(119) = Y(191) / (1. + Y(194) * CY5)
  200 DO 201  I = 1,144,13
  201 SK(I)=(1.,0.)
      RETURN
      END
```

```
      SUBROUTINE AEROB(AC,AD,VD,IL)
C     CREATE AERODYNAMICS MATRIX FOR BLADE
      COMPLEX AC,AD,VD
      COMPLEX AMF(1230)
      COMPLEX AMA(1700)
      INTEGER CY40,CY41,CY42
      COMPLEX CY1,CY2,CY5,CY6
      INTEGER CY18A
      INTEGER CY43,CY45,CY3,CY18,CY44
      DIMENSION AC(144),AD(144),VD(12)
      COMMON /AMFT/ AMF
      COMMON /AMAT/AMA
      COMMON/IS1/NFF
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      MXNFF=2*NFF+1
      DO 10 J=1,144
      AC(J)=(0.0,0.0)
   10 AD(J)=(0.0,0.0)
      DO 12  J=1,12
   12 VD(J) = (0.0,0.0)
      IPQ = 34 * (IL-1)*CY44 + (CY43+CY18A) * 34
      JPQ=3*(IL-1)*MXNFF+(NFF+CY18A)*3
   19 FORMAT(1H ,* AC,AD,VD FROM AMA*/)
      IIK=IPQ+1
      IMK=IPQ+34
   21 FORMAT (1H0,10E12.6)
      AC(39) = AMA(IPQ+1)
      AC(41) = AMA(IPQ+2)
      AC(45) = AMA(IPQ+3)
      AC(87) = AMA(IPQ+4)
      AC(89) = AMA(IPQ+5)
      AC(93) = AMA(IPQ+6)
      AC(135) = AMA(IPQ+7)
      AC(137) = AMA(IPQ+8)
      AC(141) = AMA(IPQ+9)
      IF (CY18A) 9,8,9
C     SET DIAGONALS = 1., CREATE MATRIX D.
    8 DO 101  I = 1,144,13
  101 AD(I)=(1.,0.)
    9 AD(18) = AMA(IPQ+10)
      AD(22) = AMA(IPQ+11)
      AD(37) = AMA(IPQ+12)
      AD(39) = AMA(IPQ+13)
      AD(41) = AMA(IPQ+14)
      AD(42) = AMA(IPQ+15)
```

```
      AD(45) = AMA(IPQ+16)
      AD(46) = AMA(IPQ+17)
      AD(82) = AMA(IPQ+18)
      AD(85) = AMA(IPQ+19)
      AD(87) = AMA(IPQ+20)
      AD(89) = AMA(IPQ+21)
      AD(90) = AMA(IPQ+22)
      AD(93) = AMA(IPQ+23)
      AD(94) = AMA(IPQ+24)
      AD(126) = AMA(IPQ+25)
      AD(133) = AMA(IPQ+26)
      AD(135) = AMA(IPQ+27)
      AD(137) = AMA(IPQ+28)
      AD(138) = AMA(IPQ+29)
      AD(141) = AMA(IPQ+30)
      AD(142) = AMA(IPQ+31)
C     CREATE VECTOR D.
      VD(4)=AMF(JPQ+1)
      VD(8)=AMF(JPQ+2)
      VD(12)=AMF(JPQ+3)
      RETURN
      END
```

```
      SUBROUTINE MASSB(A,F)
C
C     MASS MATRIX *A* FOR BLADE
C
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX A(144)
      COMPLEX F(12)
      COMPLEX CN9
C     CREATE MASS MATRIX FROM -Y- VECTOR FOR BLADE
      COMMON/SUB/ Y(225)
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48
     3 CY49,CY50,CY51,CY52,CY53
      COMMON/CYM1/CY56,CY57
      COMMON/CYM/CY54,CY55
      COMMON/CYM2/CY58
      CSAVE=CY4
      TURN=CY48*CY17+CY55*CY57*CY16+CY4
      ROLL=CY48*CY16-CY55*CY57*CY17
      PULL=CY54+CY55*CY56
      CY4=TURN
      CY7=CY4*CY4
      CY8=2.0*CY4
      CN1=Y(1)*CY11*CY16
      HME=Y(3)-CY58
      EPHY=Y(2)+Y(4)
C
      CY35=Y(28)*Y(19)-Y(27)
      CY36=Y(31)+Y(24)*Y(19)
      CY37=Y(26)+Y(28)*Y(20)
      CY38=Y(24)*Y(20)-Y(30)
      DO 5 I=1,144
    5 A(I)=(0.,0.)
      DO 11 I=1,144,13
   11 A(I)=(1.,0.)
      A(13) = Y(1) * (CY6 - CY7 * Y(18))
      A(15) = Y(48) * (CY8 *  Y(35) * CY5 - CY7 * Y(38))
      A(17) = -Y(1) * (CY8 * Y(36) * CY5 + CY7 * Y(39))
      A(18) = -Y(48) * (CY6-CY7 * Y(18))
      A(21) = -Y(1) * (CY8 * Y(35) * CY5 - CY7 * Y(38))
      A(37) = -Y(48) * (CY8 * Y(35) * CY5 + CY7 * Y(38))
      A(39)=Y(50)*CY6+Y(55)*CY7*Y(42)+Y(48)*CY7*(HME*Y(39)
     1+Y(4)*Y(46)+CY58*CY35)-CN1*Y(2)*Y(35)
      A(41) = -Y(48) * (CY8 * Y(15) * CY5 - CY7 * Y(43))
```

```
      A(42)=Y(56)*CY8*Y(35)*CY5*.5+Y(54)*CY7*Y(38)
      A(45)=-Y(48)*(CY6-CY7*Y(44))
      A(46)=Y(57)*CY8*Y(36)*CY5*.5+Y(52)*CY7*Y(39)
      A(73) = -Y(48) * (CY6 - CY7 * Y(18))
      A(75)=-Y(56)*CY8*Y(35)*CY5*.5+Y(55)*CY7*Y(38)
      A(77) = Y(48) * ( CY8 * Y(36) * CY5 + CY7 * Y(39))
      A(78)=(Y(49)+Y(7))*CY6+Y(54)*CY7*Y(45)+Y(48)*CY7*(HME*Y(39)
     1+Y(4)*Y(46)+CY58*CY35)-CN1*Y(2)*Y(35)
      A(81) = Y(48) * ( CY8 * Y(35) * CY5 - CY7 * Y(38))
      A(82)=-Y(58)*CY8*Y(15)*CY5*.5+Y(52)*CY7*Y(43)
      A(85) = -Y(1) * (CY8 * Y(36) * CY5 - CY7 * Y(39))
      A(87) = -Y(48) * ( CY8 * Y(15) * CY5 + CY7 * Y(43))
      A(89) = -Y(1) * (CY6 - CY7 * Y(46))
      A(90) = Y(48) * (CY8 * Y(36) * CY5 - CY7 * Y(39))
      A(93) = Y(1) * ( CY8 * Y(15) * CY5 + CY7 * Y(43))
      A(123)=-Y(57)*CY8*Y(36)*CY5*.5-Y(55)*CY7*Y(39)-Y(48)*CY7*(HME*Y(18
     1)+Y(4)*Y(39)+CY58*Y(29))-CN1*Y(2)*Y(15)
      A(126)=Y(58)*CY8*Y(15)*CY5*.5+Y(54)*CY7*Y(43)-Y(48)*CY7*(HME*Y(38)
     1-Y(4)*Y(43)+CY58*CY37)+CN1*Y(2)*Y(36)
      A(130)= Y(6) * CY6 - Y(52) * CY7 * Y(47)
      A(133)= -Y(1) * (CY8 * Y(35) * CY5 + CY7 * Y(38))
      A(135)= Y(48) * ( CY6 - CY7 * Y(44))
      A(137)=-Y(1)*(CY8*Y(15)*CY5-CY7*Y(43))
      A(138)= Y(48) * (CY8 * Y(35) * CY5 + CY7 * Y(38))
      A(141)= -Y(1) * (CY6 - CY7 * Y(44))
      DO 6 I=1,12
    6 F(I)=(0.,0.)
      CY18A=-CY18A
      IF (CY18A) 81,8,81
   81 IF (CY18A-1) 82,15,82
   82 IF (CY18A+1) 100,20,100
    8 F(2)=-Y(1)*CY7*(EPHY*Y(39)+HME*Y(18)+CY58*Y(29))
     1-CN1*Y(15)
      F(4)=Y(55)*CY7*Y(43)+Y(48)*CY7*(Y(4)*Y(43)-HME*Y(38)-CY58*CY37)
     2 +Y(2)*CN1*Y(36)
      F(7)=Y(54)*CY7*Y(39)+Y(48)*CY7*(Y(4)*Y(39)+HME*Y(18)+CY58*Y(29))
     1 +Y(2)*CN1*Y(15)
      F(8)=Y(1)*CY7*(EPHY*Y(46)+HME*Y(39)+CY58*CY35)
     2 -CN1*Y(35)
      F(11) = -Y(52) * CY7 * Y(38)
      F(12)=Y(1)*CY7*(EPHY*Y(43)-HME*Y(38)-CY58*CY37)
     2 +CN1*Y(36)
      GO TO 100
   20 CONTINUE
      S=1.
   25 CN2=Y(1)*CY11*CY17*.5
      CN3=(CY36*ROLL+CY35*PULL)*TURN
      CN4=(CY35*ROLL-CY36*PULL)*TURN
      CN5=(Y(25)*ROLL+Y(29)*PULL)*TURN
      CN6=(Y(29)*ROLL-Y(25)*PULL)*TURN
```

```
      CN7=(CY38*ROLL+CY37*PULL)*TURN
      CN8=(CY37*ROLL-CY38*PULL)*TURN
      CN9=Y(1)*(EPHY*CN3+HME*CN5+CY58*PULL*TURN-S*CY2*(
     1EPHY*CN4+HME*CN6+CY58*ROLL*TURN))
      F(2)=-CN9*Y(15)-CN2*(Y(25)-S*CY2*Y(29))
      F(8)=-CN9*Y(35)+CN2*(CY36-S*CY2*CY35)
      F(12)=+CN9*Y(36)-CN2*(CY38-S*CY2*CY37)
      F(4)=+Y(2)*F(12)-Y(53)*Y(36)*(CN3-S*CY2*CN4)+Y(57)*.5*(-CN6
     1-S*CY2*CN5)
      F(7)=-Y(2)*F(2)+Y(51)*Y(15)*(CN3-S*CY2*CN4)-Y(58)*.5*(-CN8
     1-S*CY2*CN7)
      F(11)=-Y(52)*Y(15)*(CN7-S*CY2*CN8)+Y(58)*.5*(CN4+S*CY2*CN3)
      GO TO 100
   15 CONTINUE
      S=-1.
      GO TO 25
  100 CY4=CSAVE
      CY7=CY4*CY4
      CY8=2.0*CY4
      RETURN
      END
```

```
      SUBROUTINE MLRC1 (R,T)
      REAL R(144)
      COMPLEX T(72),THLD(12)
      DO 50 I=1,12
   50 THLD(I)=(0.,0.)
      DO 100 M=1,12
      MM1=(M-1)*12
      DO 100 I=1,12
      LM=MM1+I
  100 THLD(M)=R(LM)*T(I)+THLD(M)
      DO 200 I=1,12
  200 T(I)=THLD(I)
      RETURN
      END
```

```
      SUBROUTINE MLRC2(R,T,NCOLS)
      REAL R(144)
      COMPLEX T(72), THLD(72)
      NCR=12*NCOLS
      DO 50 I=1,NCR
   50 THLD(I)=(0.,0.)
      DO 100 N=1,NCOLS
      NN1=(N-1)*12
      DO 100 M=1,12
      MM1=(M-1)*12
      K=NN1+M
      DO 100 I=1,12
      LM=MM1+I
      LN=NN1+I
  100 THLD(K)=R(LM)*T(LN)+THLD(K)
      DO 200 I=1,NCR
  200 T(I)=THLD(I)
      RETURN
      END
```

```
      SUBROUTINE MLCC1 (R,T)
      COMPLEX R(144), T(72),THLD(12)
      DO 50 I=1,12
   50 THLD(I)=(0.,0.)
      DO 100 M=1,12
      MM1=(M-1)*12
      DO 100 I=1,12
      LM=MM1+I
  100 THLD(M)=R(LM)*T(I)+THLD(M)
      DO 200 I=1,12
  200 T(I)=THLD(I)
      RETURN
      END
```

```
      SUBROUTINE MLCC2 (R,T,NCOLS)
      COMPLEX T(72), THLD(72),R(144)
      NCR=12*NCOLS
      DO 50 I=1,NCR
   50 THLD(I)=(0.,0.)
      DO 100 N=1,NCOLS
      NN1=(N-1)*12
      DO 100 M=1,12
      MM1=(M-1)*12
      K=NN1+M
      DO 100 I=1,12
      LM=MM1+I
      LN=NN1+I
  100 THLD(K)=R(LM)*T(LN)+THLD(K)
      DO 200 I=1,NCR
  200 T(I)=THLD(I)
      RETURN
      END
```

```
      OVERLAY(NS6,1,5)
      PROGRAM FKNS
      INTEGER P
      INTEGER ALP(6)
      INTEGER CY40,CY41,CY42,CY43,CY44,CY45,CY3,CY18,CY18A
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX H(60),FAH(5),FLH(5),CTH(5)
      COMPLEX FKN(123)
      COMPLEX EXPOF
      COMPLEX ZKM
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NBS,MAXN,NFP1
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/FKN1/FKN
      COMMON/IPH1/NNFAZ,NNBS
      COMMON/BETS/H,FAH,FLH,CTH
      COMMON/ISMB/MS
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/RNAME/CS(4,20),SN(4,20)
C
      DATA ALP/1,3,5,6,9,10/
C
      JJ=NP+NFP1
      DO 60 I= 1,MXSMI
      NMK=JJ-I
      IL=IABS(NMK)
      IF(NMK) 16,15,17
   15 EXPOF=(1.,0.)
      GO TO 18
   16 A=CS(MS,IL)
      B=SN(MS,IL)
      EXPOF=CMPLX(A,-B)
      GO TO 18
   17 A=CS(MS,NMK)
      B=SN(MS,NMK)
      EXPOF=CMPLX(A,B)
   18 CONTINUE
      KT1 = NRIFC*(I-1)
      IF (MS.GT.1) GO TO 35
      DO 30 JP = 1,MXT2P1
   30 FKN(KT1 + JP) = (0.0,0.0)
   35 KT = KT1 + MXT2P1 + (MS-1)*NRBD
      DO 50 P = 1,6
      L = (I-1)*12 + ALP(P)
```

```
50 FKN(KT+P)=-H(L)*EXPOF
   FKN(KT+7)=-FAH(I)*EXPOF
   FKN(KT+8)=SMLA(MS)*ZKM(I,MS)*CTH(I)*EXPOF
   IF (MFLAP) 60,60,55
55 FKN(KT+9)=-FLH(I)*EXPOF
60 CONTINUE
   RETURN
   END
```

```
      COMPLEX FUNCTION ZKM(I,MS)
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      ZKM=SMLA(MS)*(1+CY5*TAU(MS))
      RETURN
      END
```

```
      OVERLAY(NS6,1,6)
      PROGRAM QSOLN
      COMPLEX DETSV
      COMPLEX FKN(123)
      COMPLEX QU(123)
      COMPLEX TKN(1681)
      COMMON/EPSA/QU,DETSV
      COMMON/FKN1/FKN
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
      COMMON/DIMS/NN1,NN2,NN3
C
      REWIND 1
      JJ = NP + NFP1
      NCMAT = NRIFC*MXSMI
      WRITE (1) MXSMI,NRIFC,NF
      DO 10 I = 1,MXSMI
      DO 4 JP = 1,NRIFC
      LL = (I-1)*NRIFC + JP
    4 QU(LL) = FKN(LL)
      IF (NN3 .EQ. 0) GO TO 3
      WRITE(6,2000) (QU(I1),I1=1,MXQ)
    3 CONTINUE
      DO 10 J = 1,MXSMI
      CALL TKNS
      IF(NN3 .EQ. 0) GO TO 10
    5 WRITE(6,2000) (TKN(I1),I1=1,MXTKN)
 2000 FORMAT (5X,8E14.6)
   10 WRITE(1) (TKN(L ),L=1,MXTKN)
 1003 WRITE(1) (QU(L),L=1,MXQ)
 1004 REWIND 1
      WRITE(6,2000) (QU(L),L=1,MXQ)
 2222 FORMAT(1H ,2E16.7)
      RETURN
      END
```

```
      SUBROUTINE TKNS
      COMPLEX TKN(1681)
      COMMON/IPH1/NNFAZ,NNBS
      COMMON /NO4/ NCCLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON /NO5/ NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON /NO7/ I,J
      COMMON/NO8/JYPO
      COMMON /TKN1/ TKN
C
      DO 5 L=1,MXTKN
    5 TKN(L)=(0.,0.)
      IF (NSP) 10,10,25
   10 CALL BLA
      CALL BLB
      GO TO 60
   25 IF(JYPO.EQ.1) GO TO 26
      CALL SWA
      GO TO 30
   26 CALL GYA
   30 IF (NNFAZ.EQ.0) GO TO 33
      IF (I.NE.NFP1) GO TO 32
   33 IF (I.NE.J) GO TO 32
      IF(JYPO.EQ.1) GO TO 34
      CALL SWB
      GO TO 32
   34 CALL GYB
   32 CALL BLA
      CALL BLB
      IF (NB-1) 60,60,31
   31 CALL BLP
   60 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BLA
      INTEGER ALP(6)
      INTEGER Q
      COMPLEX B(1800),SMLB(300),SMLC(300),SMLD(300)
      COMPLEX TKN(1681)
      COMMON /BTS1/ B,SMLB,SMLC,SMLD
      COMMON /TKN1/ TKN
      COMMON /NO2/ MXCSB,NESBC,MXCPM,NEBC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON /NO4/ NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON /NO7/ I,J
C
      DATA ALP /1,3,5,6,9,10/
C
      DO 10 KK=1,6
      DO 10 Q=1,NCOLS
      KT=NEIFC+MXT2P1+(Q-1)*NRIFC+KK
      L=(J-1)*NEBC+(I-1)*MXCPM+(Q-1)*12+ALP(KK)
   10 TKN(KT)=B(L)
      DO 15 KK=1,6
      KT=NEIFC+NCOLS*NRIFC+MXT2P1+KK
      L=(J-1)*NESBC+(I-1)*MXCSB+ALP(KK)
   15 TKN(KT)=-SMLC(L)
      DO 16 KK=1,6
      KT=NEIFC+(NCOLS+1)*NRIFC+MXT2P1+KK
      L=(J-1)*NESBC+(I-1)*MXCSB+ALP(KK)
   16 TKN(KT)=-SMLB(L)
      IF (MFLAP) 23,23,21
   21 DO 22 KK=1,6
      KT=NEIFC+(NCOLS+2)*NRIFC+MXT2P1+KK
      L=(J-1)*NESBC+(I-1)*MXCSB+ALP(KK)
   22 TKN(KT)=-SMLD(L)
   23 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BLB
      INTEGER Q
      COMPLEX FAB(150),FLB(150),CTB(150)
      COMPLEX FASB(25),CTSB(25),FLSB(25),FLSC(25),
     1 FASD(25),CTSD(25),FLSD(25),FASC(25)
      COMPLEX TKN(1681)
      COMPLEX YKM
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/BTS2/FAB,FLB,CTB
      COMMON/BTS3/FASB,CTSB,FLSB,FLSC,FASD,CTSD,FASC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMCN/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
C
      MS=1
      DO 10 Q=1,NCOLS
      KT=NEIFC+MXT2P1+(Q-1)*NRIFC
      L=(J-1)*NCOLS*MXSMI+(I-1)*NCOLS+Q
      TKN(KT+7)=FAB(L)
      TKN(KT+8)=-SMLA(MS)*CTB(L)*YKM(I,MS)
      IF(MFLAP.EQ.0) GO TO 10
      TKN(KT+9)=FLB(L)
   10 CONTINUE
      KT=NEIFC+NRIFC*(NCOLS+1)+MXT2P1+NCOLS
      L=(J-1)*MXSMI+(I-1)+1
      TKN(KT+1)=-FASB(L)
      TKN(KT+2)=AKCI(MS)*CTSB(L)
      KT1=KT+NRIFC
      IF(MFLAP.EQ.0) GO TO 11
      IF(NFLAP.GT.NFEA) GO TO 12
      TKN(KT1+1)=-FASD(L)
   12 IF(NFLAP.GT.NCT) GO TO 11
      TKN(KT1+2)=SMLA(MS)*YKM(I,MS)*CTSD(L)
   11 CONTINUE
      IF(MFLAP.EQ.0) GO TO 20
      IF(NFLAP.LE.NFEA) GO TO 14
      KT2=NEIFC+MXT2P1+NRIFC*NCOLS+NCOLS
      TKN(KT2+3)=-FLSC(L)
   14 IF(NFLAP.LE.NCT) GO TO 20
      TKN(KT+3)=-FLSB(L)
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE BLP
      INTEGER P,Q
      COMPLEX EXPON
      COMPLEX TKN(1681)
      COMPLEX YKM
      COMPLEX FAB(150),FLB(150),CTB(150)
      COMPLEX FASB(25),CTSB(25),FLSB(25),FLSC(25),
     1 FASD(25),CTSD(25),FLSD(25),FASC(25)
C
      COMMON /AKTAU/ AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/BTS2/FAB,FLB,CTB
      COMMON/BTS3/FASB,CTSB,FLSB,FLSC,FASD,CTSD,FASC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO6/NPBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON /NO7/ I,J
      COMMON /TKN1/ TKN
      NMK =J - I
      K1 = NEIFC + MXT2P1
      K2 = K1 + 8
      DO 20 MS = 2, NB
      K3 = (MS-1) * (NEISC+NRBD)
      DO 5 Q = 1,NRBD
      K4 = K1 + (Q - 1)*NRIFC
      DO 5 P = 1, NRBD
      KT = K4 + P
      KT2 = KT + K3
    5 TKN(KT2) = TKN(KT) * EXPON(NMK,MS)
      DO 10 Q = 1, NCOLS
      KT = K2 + K3 + (Q - 1) * NRIFC
      L=(J-1)*NCOLS*MXSMI + (I-1) * NCOLS + Q
   10 TKN(KT) =-SMLA(MS)*CTB(L)*YKM(I,MS)*EXPON(NMK,MS)
      KT=K2+K3+(NCOLS+1)*NRIFC
      L=(J-1)*MXSMI+(I-1)+1
      TKN(KT) =AKCI(MS)*CTSB(L)*EXPON(NMK,MS)
      IF(MFLAP.EQ.0)GO TO 20
      IF(NFLAP.GT.NCT)GO TO 20
      KT1=KT+NRIFC
      TKN(KT1) =SMLA(MS)*YKM(I,MS)*CTSD(L)*EXPON(NMK,MS)
   20 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE SWA
      INTEGER P,Q,QS
      COMPLEX TKN(1681)
      COMPLEX XNLQ
      COMPLEX YKM
      COMPLEX ZLN
      COMPLEX VLN
      COMPLEX WNLQ
      COMPLEX EXPON
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NRIFC,NRISC,MXTKN,NIG
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
      COMMON/IPH1/NNFAZ,NNBS
      COMMON/AERDM/DMS(4)
      COMMON/SWASH/SWGJ,SWEI,SWM,SWR
      IF (I.NE.J) GO TO 30
C     THE I=J TERMS ARE THE SMALL K=SMALL N TERMS
      DO 17 L=1,MXT2P1
      LS = L-MAXN-1
      LL = (L-1)*NRIFC +L
   17 TKN(LL) = ZLN(LS,I)+VLN(I,LS)
      DO 20 MS = 1,NB
      DO 20 L = 1,MXT2P1
      LS = L-MAXN-1
      CFDL=1.+DMS(MS)*(1.+(LS*LS-1)/(1.+LS*LS*SWGJ/SWEI))/SWR
      LL = (L-1)*NRIFC +MXT2P1 +(MS-1)*NRBD +8
   20 TKN(LL) = YKM(I,MS)*EXPON(LS,MS)*CFDL
      GO TO 50
   30 IMJ = I-J
      DO 18 L= 1,MXT2P1
      DO 18 Q = 1,MXT2P1
      IF (L.EQ.Q) GO TO 18
      LMQ = L-Q
      IF (IMJ.NE.LMQ) GO TO 18
      LS = L-MAXN-1
      QS = Q-MAXN-1
      LL = (L-1)*NRIFC +Q
      TKN(LL) = XNLQ(I,LS,QS) + WNLQ(I,LS,QS)
   18 CONTINUE
   50 RETURN
      END
```

```
      SUBROUTINE SWB
      INTEGER P,Q,QS
      COMPLEX TKN(1681)
      COMPLEX EXPON
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO5/NP,NSP,MODE,MFP,NOUT,MXQ,NAS,NBS,NET,NPS
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/AERDM/DMS(4)
      COMMON/SWASH/SWGJ,SWEI,SWM,SWR
C
      IF (NBS.EQ.0) GO TO 13
      KSML=I-NFP1
      NPMK=NP-KSML
      DO 14 Q=1,MXT2P1
      QS=Q-MAXN-1
      NMKQ=NPMK-QS
      IF(NMKQ.EQ.0) GO TO 5
      RNMKQ=1.0*NMKQ
      RFA=RNMKQ/NBS
      NFA=NMKQ/NBS
      DIF=RFA-1.0*NFA
      IF(DIF.GE.0.0) GO TO 2
      DIF=-DIF
    2 IF(DIF.GT..05) GO TO 14
    5 LL=NEIFC+NRIFC*(NCOLS+NCSB)+Q
      DFQR=1.0+DMS(1)*(1+(QS*QS-1)/(1+QS*QS*SWGJ/SWEI))/SWR
      TKN(LL)=-NBS*DFQR/SMLA(1)
   14 CONTINUE
      GO TO 23
   13 DO 21 MS=1,NB
      DO 21 Q=1,NCSB
      DO 21 P=1,MXT2P1
      QS=P-MAXN-1
      LL=NEIFC+(MS-1)*NEISC+NRIFC*(NCOLS+NCSB)+(Q-1)*NRIFC+P
      DFQR=1+DMS(MS)*(1+(QS*QS-1)/(1+QS*QS*SWGJ/SWEI))/SWR
   21 TKN(LL)= - EXPON(-QS,MS)*DFQR/SMLA(MS)
   23 RETURN
      END
```

```
      SUBROUTINE GYA
      INTEGER Q,QS
      COMPLEX YKM
      COMPLEX TKN(1681)
      COMPLEX GZLN
      COMPLEX GXN
      COMPLEX GXNK
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX EXPON
      COMMON/NO3/ NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
      COMMON/IPH1/NNFAZ,NNBS
      COMMON/GYR/GYM,GYK,GYC,GKB,GCB,GKP,GCP,GRP,GIX,GIY,GIZ
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /RNAME/ CS(4,20),SN(4,20)
      JMI=J-I
      IF (JMI.NE.0) GO TO 30
C
C        COMPUTES DIAGONAL ELEMENTS OF DIAGONAL BLOCKS
C
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      CY6=CY5*CY5
      DO 5 L=1,MXT2P1
      LS=L-MAXN-1
      LL=(L-1)*NRIFC+L
      IF (LS) 2,3,4
    2 GZLN=CY6*GIX+CY5*GCB+GKB+CY7*(GIZ-GIY)
      GO TO 5
    3 GZLN=CY6*GYM+CY5*GYC+GYK
      GO TO 5
    4 GZLN=CY6*GIY+CY5*GCB+GKB+CY7*(GIZ-GIX)
    5 TKN(LL)=GZLN
C
C        COMPUTES OFF DIAGONAL ELEMENTS OF DIAGONAL BLOCKS
C
      IF (MAXN.EQ.0) GO TO 10
      Q=MXT2P1
      L=MXT2P1
      TKN(Q)=-CY4*(CY5*(GIZ-GIX-GIY)-GCB)
      LL=(L-1)*NRIFC+1
      TKN(LL)=-TKN(Q)
C
```

```
C         COMPUTES BLADE COUPLING TERMS
C
   10 CONTINUE
      DO 20 MS=1,NB
      DO 20 L=1,MXT2P1
      LS=L-MAXN-1
      LL=(L-1)*NRIFC+MXT2P1+(MS-1)*NRBD+8
      IF(LS) 6,7,8
    6 TKN(LL)=-GRP*SN(MS,1)*YKM(I,MS)
      GO TO 20
    7 TKN(LL)=-YKM(I,MS)
      GO TO 20
    8 TKN(LL)=GRP*CS(MS,1)*YKM(I,MS)
   20 CONTINUE
      GO TO 50
C
C         COMPUTES OFF DIAGONAL TERMS IN OFF DIAGONAL BLOCKS
C
   30 IF ((JMI-2).EQ.0) GO TO 35
      IF ((JMI+2).EQ.0) GO TO 35
      GO TO 50
   35 MX=MAXN+1
      KSML=J-NFP1
      CY5=CY1-CY2*KSML*CY4
      GXNK=GKP+CY5*GCP+.5*CY2*CY4*GCP*JMI
      DO 40 L=1,MXT2P1
      DO 40 Q=1,MXT2P1
      IF (L.EQ.MX) GO TO 40
      IF (Q.EQ.MX) GO TO 40
      LS=L-MAXN-1
      QS=Q-MAXN-1
      IL=(L-1)*NRIFC+Q
   40 TKN(IL)=-.25*GXNK*(LS+QS-CY2*LS*(LS-QS)*JMI*.5)
   50 CONTINUE
      RETURN
      END
```

```
      SUBROUTINE GYB
C
C        CANNOT HANDLE NBS GREATER THAN ZERO
C
      INTEGER Q,QS
      COMPLEX TKN(1681)
      COMMON/NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NE,NEIFC,NEISC,MXTKN,NIG
      COMMON/NO6/NRBD,NRIFC,MXSMI,NFLAP,MFLAP,NCT,MXT2P1,NCSB
      COMMON/NO7/I,J
      COMMON/TKN1/TKN
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/RNAME/CS(4,20),SN(4,20)
      COMMON/GYR/GYM,GYK,GYC,GKB,GCB,GKP,GCP,GRP,GIX,GIY,GIZ
C
      DO 20 MS=1,NB
      DO 20 Q=1,MXT2P1
      QS=Q-MAXN-1
      LL=NEIFC+(MS-1)*NEISC+NRIFC*(NCOLS+1)+Q
      IF (QS) 2,4,6
    2 TKN(LL)=GRP*SN(MS,1)/SMLA(MS)
      GO TO 20
    4 TKN(LL)=1.0/SMLA(MS)
      GO TO 20
    6 TKN(LL)=-GRP*CS(MS,1)/SMLA(MS)
   20 CONTINUE
      RETURN
      END
```

```
      COMPLEX FUNCTION EXCHI(L,Q,J)
C  CREATE EXP(I*(L-Q)*CHI(J))
      INTEGER Q
      COMMON/RNAME1/CS1(4,06),SN1(4,06)
      LQ=L-Q
      ILQ=IABS(LQ)
      IF(LQ) 16,15,17
   15 EXCHI=(1.,0.)
      GO TO 18
   16 A= CS1(J,ILQ)
      B=SN1(J,ILQ)
      EXCHI= CMPLX(A,-B)
      GO TO 18
   17 A=CS1(J,ILQ)
      B=SN1(J,ILQ)
      EXCHI=CMPLX(A,B)
   18 CONTINUE
      RETURN
      END
```

```
      COMPLEX FUNCTION EXPON(L,MS)
C  CREATE EXP(I*L*PHIM)
      COMMON/RNAME/CS(4,20),SN(4,20)
      IL=IABS(L)
      IF(L) 16,15,17
   15 EXPON=(1.,0.)
      GO TO 18
   16 A=CS(MS,IL)
      B=SN(MS,IL)
      EXPON=CMPLX(A,-B)
      GO TO 18
   17 A=CS(MS,L)
      B=SN(MS,L)
      EXPON=CMPLX(A,B)
   18 CONTINUE
      RETURN
      END
```

```
      COMPLEX FUNCTION VLN(I,LS)
      COMPLEX VN,VN1,VN2
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMMON /AEBBP/ BJ(4)
      COMMON /AEBTP/ AKT(4),ACT(4),AKP(4),ACP(4)
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZBY,NFEA,NES,MAXN,NFP1
      COMMON /SWASH/ SWGJ,SWEI,SWM,SWR
      R=SWR
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      CFL=1.+(LS*LS-1)/(1+LS*LS*SWGJ/SWEI)
      VN=(0.,0.)
      VN1=(0.,0.)
      VN2=(0.,0.)
      DO 5 J=1,NES
      VN=VN+AKT(J)+(CY5-CY2*LS*CY4)*ACT(J)
      VN1=VN1+(AK(J)+(CY5-CY2*LS*CY4)*AC(J))*BJ(J)*(R-BJ(J)*CFL)
5     VN2=VN2+AKP(J)+(CY5-CY2*LS*CY4)*ACP(J)
      VLN = (LS*LS*VN-VN1*CFL+CFL*CFL*VN2)/(R*R)
      RETURN
      END
```

```
      COMPLEX FUNCTION WNLO(I,IS,QS)
      COMPLEX EXCHI
      COMPLEX WN,WN1,WN2
      INTEGER QS
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMMON /AERBP/ BJ(4)
      COMMON /AERTP/ AKT(4),ACT(4),AKP(4),ACP(4)
      COMMON/AKTAU/AKC1(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON /SWASH/ SWGJ,SWEI,SWM,SWR
      R=SWR
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      CFQ=1.+(QS*QS-1)/(1.+QS*QS*SWGJ/SWEI)
      CFL = 1.+(LS*LS-1)/(1.+LS*LS*SWGJ/SWEI)
      WN=(0.,0.)
      WN1=(0.,0.)
      WN2=(0.,0.)
      DO 5 J=1,NES
      WN=WN+(AKT(J)+(CY5-CY2*QS*CY4)*ACT(J))*EXCHI(LS,QS,J)
      WN1=WN1+(AK(J)+(CY5-CY2*QS*CY4)*AC(J))*BJ(J)*(R-BJ(J)*CFQ)
     1 *EXCHI(LS,QS,J)
    5 WN2=WN2+(AKP(J)+(CY5-CY2*QS*CY4)*ACP(J))*EXCHI(LS,QS,J)
      WNLQ = (QS*LS*WN-WN1*CFL+CFQ*CFL*WN2)/(R*R)
      RETURN
      END
```

```
      COMPLEX FUNCTION XNLQ(I,LS,QS)
      INTEGER QS
      COMPLEX EXCHI
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6,XN,XN1,XN2,XN3
      COMPLEX C5
      COMMON/AERBP/BJ(4)
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON /SWASH/ SWGJ,SWEI,SWM,SWR
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      IF(QS .EQ. LS) GO TO 15
      XNLQ=(0.,0.)
      CFQR=(1.+(QS*QS-1)/(1.+QS*QS*SWGJ/SWEI))/SWR
      CFLR=(1.+(LS*LS-1)/(1.+LS*LS*SWGJ/SWEI))/SWR
      DO 10  J=1,NES
   10 XNLQ=XNLQ+(AK(J)+(CY5-CY2*QS*CY4)*AC(J))*EXCHI(LS,QS,J)*
     1 (1.-BJ(J)*CFQR)
      IF(NIG .EQ. 0) GO TO 16
      C5=CAPK+CAPC*(CY5-CY2*QS*CY4)
      XN1=(0.,0.)
      XN2=(0.,0.)
      XN3=(0.,0.)
      DO 12 J=1,NES
      XN=AK(J)+(CY5-CY2*QS*CY4)*AC(J)
      XN1=XN1+XN
      XN2=XN2+XN*EXCHI(LS,0,J)*(1.-BJ(J)*CFLR)
   12 XN3=XN3+XN*EXCHI(0,QS,J)*(1.-BJ(J)*CFQR)
      XNLQ=XNLQ-XN3*XN2/(C5+XN1)
      GO TO 16
   15 XNLQ=(0.,0.)
   16 CONTINUE
      RETURN
      END
```

```
      COMPLEX FUNCTION YKM(I,MS)
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,CY48,
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZEY,NFEA,NES,MAXN,NFP1
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      YKM=SMLA(MS)*(1+CY5*TAU(MS))
      RETURN
      END
```

```
      COMPLEX FUNCTION ZLN(LS,I)
      INTEGER CY18A
      INTEGER CY40,CY41,CY42
      INTEGER CY43,CY45,CY3,CY18,CY44
      COMPLEX CY1,CY2,CY5,CY6
      COMPLEX EXCHI,CLNJ
      COMPLEX C1,C2,C5,C6,C7,C8,C9,C10
      COMMON/AERBP/BJ(4)
      COMMON/AKTAU/AKCI(4),TAU(4),SMLA(4),AK(4),AC(4),CAPK,CAPC
      COMMON/CYI/CY3,CY18,CY40,CY41,CY42,CY43,CY44,CY45,CY18A
      COMMON/CYC/CY1,CY2,CY5,CY6
      COMMON/CYR/CY4,CY7,CY8,CY9,CY10,CY11,CY12,CY13,CY14,CY15,CY16,
     1 CY17,CY19,CY20,CY21,CY22,CY23,CY24,CY25,CY26,CY27,CY28,CY29,
     2 CY30,CY31,CY32,CY33,CY34,CY35,CY36,CY37,CY38,CY39,CY46,CY47,C
     3 CY49,CY50,CY51,CY52,CY53
      COMMON /NO3/NS,NSIZMY,NFMA,NES,MAXN,NFP1
      COMMON/NO4/NCOLS,NB,NF,NEIFC,NEISC,MXTKN,NIG
      COMMON /SWASH/ SWGJ,SWEI,SWM,SWR
C
      R=SWR
      KSML=I-NFP1
      CY5=CY1-CY2*KSML*CY4
      CY6=CY5*CY5
      C1=SWM*(CY6-CY8*LS*CY2*CY5-LS*LS*CY7)
      C2=(0.,0.)
      C9=(0.,0.)
      CFLR=(1.+(LS*LS-1)/(1+LS*LS*SWGJ/SWEI))/SWR
      DO 10 J=1,NES
      CLNJ=AK(J)+CY5*AC(J)-CY2*LS*CY4*AC(J)
      C2=C2+CLNJ
   10 C9=C9+CLNJ*(1-BJ(J)*CFLR)
      C10=C2
      C2=C9
      IF (NIG .EQ. 0) GO TO 11
      C2=C10
      C5=CAPK+CAPC*(CY5-CY2*LS*CY4)
      C6=(0.,0.)
      C7=(0.,0.)
      DO 8 J=1,NES
      C8=AK(J)+CY5*AC(J)-CY2*LS*CY4*AC(J)
      C6=C6+C8*EXCHI(LS,1,J)*(1.-BJ(J)*CFLR)
    8 C7=C7+C8*EXCHI(0,LS,J)*(1-BJ(J)*CFLR)
      C2=C9-C7*C6/(C5+C2)
   11 IF (MAXN .EQ. 1) GO TO 12
      KX=1-LS*LS
      C3=2.*CY12*LS*LS*KX*KX
      C4=R*R*R*(1./SWGJ+LS*LS/SWEI)
      C3=C3/C4
      ZLN=C1+C2+CMPLX(C3,0.)
      GO TO 13
```

```
12 ZLN=C1+C2
13 RETURN
   END
```

```
      OVERLAY(NS6,2,0)
      PROGRAM SOLVE
      COMPLEX DB(123,123),DTPHAS,DPIVOT
      COMPLEX B(123,123)
      COMPLEX EPS(123)
      COMPLEX DETSV
      EQUIVALENCE (DB,B)
      COMMON /EPSA/ EPS,DETSV
      COMMON/IWA4/NN4,NN5,NN6
      COMMON /CDETRM/ DPIVOT,DTPHAS,DTLG10,IDET
      REWIND 1
      READ (1) MXSMI,NRIFC,NF
      NORDER=MXSMI*NRIFC
      CALL INRAY (B,MXSMI,NRIFC)
      READ (1) (EPS(I),I=1,NORDER)
      REWIND 1
      IDET=0
      N=NORDER
      CALL DCMAT (DB,N,EPS)
      WRITE(6,700) (EPS(I),I=1,NORDER),DETSV
    5 CONTINUE
  700 FORMAT(5X,8E14.6)
      RETURN
      END
```

```
      SUBROUTINE INRAY (B,MXSMI,NRIFC)
      COMPLEX B(123,123)
      DO 1 L=1,MXSMI
      IROWF=L*NRIFC
      IROWS=IROWF-NRIFC+1
      DO 1 K=1,MXSMI
      ICOLF=K*NRIFC
      ICOLS=ICOLF-NRIFC+1
    1 READ(1) ((B(I,J),I=IROWS,IROWF),J=  ICOLS,ICOLF)
      RETURN
      END
```

```
      SUBROUTINE DCMAT(A,N,Y)
      COMPLEX A(123,123),Y(123),DDET,DAIJ,AMX,DONE,DYI,TEMP,DAKJ,
     1DYK,DAKK,DAIK,DPIVOT,DPHAS
      COMPLEX X(123),TK,ONE
      DIMENSION ICHG(123)
      COMMON /CDETRM/ DPIVOT,DPHAS,ADET,IDET
C
      NDIM=123
      ADET=0.0
      DSIGN=1.0
      DPHAS=CMPLX(1.0,0.0)
      ONE=1.0
      ZERO=0.0
      NP1=N
      IF(IDET.EQ.0) GO TO 650
      NP1=N+1
      DO 651 I=1,NP1
  651 X(I)=A(NP1,I)
  650 CONTINUE
      DO 118 K=1,N
      AMX = A(K,K)
      IMX=K
      DO 100 I=K,N
      IF(CABS(A(I,K)) .LE. CABS(AMX)) GO TO 100
      AMX = A(I,K)
      IMX=I
  100 CONTINUE
  102 IF (IMX.EQ.K) GO TO 106
      DO 104 J=1,NP1
      TEMP=A(K,J)
      A(K,J)=A(IMX,J)
  104 A(IMX,J)=TEMP
      ICHG(K)=IMX
      TEMP=Y(K)
      Y(K) = Y(IMX)
      Y(IMX) = TEMP
      DPHAS=-DPHAS
      GO TO 108
  106 ICHG(K)=K
  108 CONTINUE
      DAKK=A(K,K)
  901 FORMAT(1X,I5,2E40.16/)
      AMAG=CABS(DAKK)
      IF (AMAG.NE.ZERO) GO TO 6
      WRITE(6,7)
    7 FORMAT(*0    MATRIX IN DCMAT IS SINGULAR*)
      STOP
    6 CONTINUE
      ADET=ADET+ALOG10(AMAG)
      DPHAS=DPHAS*DAKK/AMAG
```

```
      DONE=CMPLX(1.0,0.0)
      DAKK=DONE/DAKK
      DO 110 J=1,NP1
  110 A(K,J)=A(K,J)*DAKK
      A(K,K)=DAKK
      IF(IDET.EQ.0) GO TO 652
      TK=X(K)
      DO 653 J=K,NP1
  653 X(J)=X(J)-TK*A(K,J)
  652 CONTINUE
      DYK=Y(K)
      Y(K)=DYK*DAKK
      DO 114 I=1,N
      IF (I.EQ.K) GO TO 114
      DAIK=A(I,K)
      DO 112 J=1,NP1
  112 A(I,J)=A(I,J)-DAIK*A(K,J)
C     CALL ROWSUM(NP1,NDIM,A(I,1),A(K,1),DAIK)
      A(I,K)=DAIK
      DYI=Y(I)
      DYK=Y(K)
      Y(I)=DYI-DAIK*DYK
  114 CONTINUE
      DO 116 I=1,N
  116 A(I,K)=-A(I,K)*DAKK
      A(K,K)=DAKK
  118 CONTINUE
      DO 122 K=1,N
      L=N+1-K
      KI=ICHG(L)
      IF (L.EQ.KI) GO TO 122
      DO 120 I=1,N
      TEMP = A(I,L)
      A(I,L) = A(I,KI)
  120 A(I,KI) = TEMP
  122 CONTINUE
      IF(IDET.NE.0) DPIVOT=X(NP1)
  124 RETURN
      END
```

Machine Compatibility

The Swashplate Dynamic Response Program has been run on NASA-Langley's CDC 6600 and CDC 6400 systems. The program was developed utilizing standard FORTRAN IV and is also WATFIV compatible. The program has not been run in its present form on an IBM 360/65. To execute this program on an IBM system the overlay cards would have to be removed and replaced with an IBM overlay structure and the PROGRAM cards changed to SUBROUTINE cards (for example, the PROGRAM SETUP card would have to be replaced with a SUBROUTINE SETUP card). In addition, the core requirements may be restrictive, especially if it is necessary to convert the program to double precision for accuracy of results to be equivalent to that obtained on a CDC system.

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
WASHINGTON, D.C. 20546

OFFICIAL BUSINESS
PENALTY FOR PRIVATE USE $300

SPECIAL FOURTH-CLASS RATE BOOK

POSTAGE AND FEES PAID
NATIONAL AERONAUTICS AND SPACE ADMINISTRATION
451

U.S. MAIL

POSTMASTER: If Undeliverable (Section 158 Postal Manual) Do Not Return

"The aeronautical and space activities of the United States shall be conducted so as to contribute . . . to the expansion of human knowledge of phenomena in the atmosphere and space. The Administration shall provide for the widest practicable and appropriate dissemination of information concerning its activities and the results thereof."

—NATIONAL AERONAUTICS AND SPACE ACT OF 1958

NASA SCIENTIFIC AND TECHNICAL PUBLICATIONS

TECHNICAL REPORTS: Scientific and technical information considered important, complete, and a lasting contribution to existing knowledge.

TECHNICAL NOTES: Information less broad in scope but nevertheless of importance as a contribution to existing knowledge.

TECHNICAL MEMORANDUMS: Information receiving limited distribution because of preliminary data, security classification, or other reasons. Also includes conference proceedings with either limited or unlimited distribution.

CONTRACTOR REPORTS: Scientific and technical information generated under a NASA contract or grant and considered an important contribution to existing knowledge.

TECHNICAL TRANSLATIONS: Information published in a foreign language considered to merit NASA distribution in English.

SPECIAL PUBLICATIONS: Information derived from or of value to NASA activities. Publications include final reports of major projects, monographs, data compilations, handbooks, sourcebooks, and special bibliographies.

TECHNOLOGY UTILIZATION PUBLICATIONS: Information on technology used by NASA that may be of particular interest in commercial and other non-aerospace applications. Publications include Tech Briefs, Technology Utilization Reports and Technology Surveys.

Details on the availability of these publications may be obtained from:

SCIENTIFIC AND TECHNICAL INFORMATION OFFICE

NATIONAL AERONAUTICS AND SPACE ADMINISTRATION

Washington, D.C. 20546